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The resilience of the City of Kelowna: Exploring mitigation before, during and after the Okanagan Mountain Park Fire

By Dan Sandink

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ICLR's mission is to reduce the loss of life and property caused by severe weather and earthquakes through the identification and support of sustained actions that improve society's capacity to adapt to, anticipate, mitigate, withstand and recover from natural disasters. ICLR is achieving its mission through the development and implementation of its programs *Open for Business™,* to increase the disaster resilience of small businesses, *Designed… for safer living*, which increases the disaster resilience of homes, and *RSVP cities*, to increase the disaster resilience of communities.

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Executive summary

Resilience is the ability of a community to "bounce back" from adversity. A disaster resilient community employs tools and strategies to mitigate the impacts of, and quickly and effectively recover from disasters. The City of Kelowna suffered significant adversity during the Okanagan Mountain Park Fire (OMPF) of 2003, including significant damage to private property, homes, infrastructure, as well as an evacuation of a significant portion of the City's population. The OMPF was a severe Wildland-Urban Interface (WUI) fire event that resulted in the destruction of 238 homes, the evacuation of approximately one third of the population of the City of Kelowna, and was considered the most destructive WUI fire in Canadian history. Damages to the City of Kelowna alone were estimated at $100 million.

This paper provides a discussion of a resilient community, through the exploration of impacts, reactions and mitigative adjustments adopted by the City of Kelowna before, during and after the OMPF. The paper provides context for disaster mitigation decision making in Canada and British Columbia, including a review of relevant legislation and government programs related to emergency management. This paper discusses the adoption of mitigation measures in the City of Kelowna, as well as barriers that led to reduced adoption of mitigative adjustments, and obstacles that had to be overcome to implement measures. Methods for the study included meetings and interviews with key City of Kelowna staff, reviews of internal documents and literature reviews.

Mitigation measures adopted by the City of Kelowna and discussed in this report include:

- An analysis of the impacts of the wildfire on watersheds surrounding the municipality, and actions taken to regenerate biota to mitigate post-wildfire flood risks, as well as infrastructure improvements to address increased flood risks following wildfires;
- Creation of "development permit" areas to address fuel loads in newly developed lands within WUI fire risk areas. The development permit areas were defined based on a reassessment of previous fire risk maps;
- Wildfire abatement covenants, which address wildfire risk in newly developed lands and set out responsibilities for management of wildfire risk by property owners;
- An extensive policy and procedure review (see Blackwell & Needoba, 2006), including a public consultation process, which produced 25 recommendations, 14 of which were adopted as action items for the year of 2007;
- Dissemination of FireSmart wildfire risk reduction information to private property owners within the City's jurisdiction, and;
- Implementation of fuel management strategies since 1998, and the development of a fuel management strategy to address future wildfire risk in the WUI (developed in 2004).

The city independently developed effective communications strategies (response) and a recovery resource management strategy (recovery) as well. Though these strategies cannot be considered mitigation, they provide evidence of an autonomous and adaptable municipal government, thus displaying characteristics of a resilient system.

Further aspects of fire and post-fire hazard mitigation explored in this study include:

- The impacts of the OMPF on various departments in the City;
- City staff learning from their experience with WUI management in other communities, and research on communities that had experienced similar WUI fire events;
- A fire guard created during the emergency that protected Kelowna communities from the oncoming OMPF;
- A significant evacuation effort;
- Insurance, government relief and recovery resource management;
- Recovery centres to assist those affected by the fire, and;
- A post-disaster policy window (window of opportunity) created by the OMPF.

Various barriers and obstacles to the implementation of mitigation strategies were identified by City of Kelowna staff. A window of opportunity was created in Kelowna following the OMPF, in which political and public interest in mitigation was high and there was a stronger possibility for the introduction of new mitigation measures or improvements to existing mitigation measures. Respondents in this study generally estimated that the window of opportunity was two years in length. Various mitigation measures were developed or improved during this time period, including measures focussed on reducing post-wildfire flood risk. However, litigation brought against the city that resulted from damages from the OMPF served to reduce the ability of the City to implement new mitigation strategies during the window of opportunity. Further barriers and obstacles identified in this study included jurisdictional issues regarding bylaws and requirements for fire-resistant building materials and fuel management in Crown lands, the cost of some typesof mitigation options and the changing nature of wildland-urban interface zones (uncertainty). Public perceptions of fuel management approaches and public willingness to adopt mitigation approaches on their own property were also identified as barriers to effective adoption of WUI fire management practices in the City.

Respondents identified limited support from higher levels of government for mitigation approaches pursued by the City as an obstacle to implementing mitigation strategies. Specifically, no financial support was provided to the City for several aspects of the City's post-wildfire flood risk management work. Review of provincial and federal emergency management policy and legislation revealed limited support for mitigation as a component of emergency management.

Resilience characteristics evident in the City included redundancy, diversity, efficiency, autonomy, resistance, adaptability, and a collaborative approach. The fire affected a variety of City departments, and mitigation strategies adopted required cross-departmental participation and collaboration. The City of Kelowna adopted an interdependent approach to the management of wildland fire risk, across all levels of WUI fire risk (property, subdivision, landscape).

The City of Kelowna has employed many actions to manage wildfire risk, including actions that were initiated before, during and after the OMPF. Respondents believed that the City's experience with the OMPF, combined with effective mitigation, response and recovery programs would reduce the impacts of future wildfires in Kelowna. Further, the City applied lessons learned from other communities in emergency management approaches. The City was also able to adapt to barriers and obstacles presented in various attempts to control WUI fire hazards and post-fire hazards. As well, new recovery and mitigation programs emerged as new challenges were presented during response and recovery from the OMPF. Barriers to disaster mitigation at the local level should be further studied, and strategies to overcome barriers should be identified. The case study explored in this paper found a municipal staff both willing and able to implement strategies to decrease risk to residents, property and infrastructure. Emergency management in Canada should be altered to allow those cities that are willing and able to pursue actions to mitigate disaster risk.

1. Introduction

Natural disasters pose a significant and increasing risk to Canadian communities. *The Canadian Disaster Database* reports an increase of over 300% in the number of meteorological and hydrological disasters reported between the 1960s and the 1990s (PSC, 2007a). Global statistics report a ten-fold increase in insured damages between the 1970s and the 2000s (Swiss Re, 2007) and a ten-fold increase in the number of disasters reported between 1975 and 2005 (EM-DAT, 2008). Disaster losses are expected to grow as climate change impacts the frequency and severity of extreme climatic events. The Intergovernmental Panel on Climate Change's 2007 report suggests climate change impacts in Canada could affect wind intensity, extreme precipitation and drought conditions, and will lead to an increase in the number of hot days (Field et al., 2007; McBean, 2004).

Vulnerability factors, including increasing population and wealth, urbanization, increased exposure to hazards through development in hazardous areas, environmental degradation and aging infrastructure will also increase disaster damages (Etkin, 1999; de Sherbinin *et al*., 2007). Further, risk perceptions will have a continued impact on the vulnerability of individuals who occupy hazard prone areas, and on political choice to implement disaster mitigation policies. Institutional arrangements with a strong focus on preparedness, emergency response, post-disaster clean-up and returning communities "back to normal" with limited focus on mitigation have also affected the vulnerability of Canadian communities. Thus, there is a need to foster sustainable disaster mitigation and resilience to counteract rising disaster risk and vulnerability.

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Resilient communities have the capacity to learn and adjust, use all forms of knowledge and develop linkages between institutions to foster sustainable disaster mitigation initiatives. Further, a resilient community can recover from disaster events with limited outside assistance (Mileti, 1999). Resilience to natural hazards can largely be achieved through the implementation of effective and sustainable disaster mitigation initiatives that have a focus on reducing vulnerability to hazards. In Canada, emergency management is, in some way, addressed by all levels of government. Disaster mitigation, however, is largely delegated to municipal governments. Communities can counteract the impacts of disasters by incorporating resilience into their policies, including incorporation of disaster resilience into land-use planning and subdivision design, and ensuring proper mitigation techniques are applied at the private property level. However, research has revealed limited adoption of mitigative adjustments at this level (Newton, 2003).

This paper provides a discussion of a resilient community, through the exploration of impacts, reactions and mitigative adjustments adopted by the City of Kelowna before, during and after the Okanagan Mountain Park Fire (OMPF) of 2003. The OMPF was a severe Wildland-Urban Interface (WUI) fire event that resulted in the destruction of 238 homes, the evacuation of approximately one third of the population of the City of Kelowna, and was considered the most destructive WUI fire in Canadian history. Damages to the City of Kelowna alone were estimated at $100 million (Dobson, 2006).

A workshop and follow-up interviews with high level staff were applied to gain insights into Kelowna's experience with the OMPF. The study provides the exploration in the context of resilience, including exploration of the impacts of the OMPF on various departments in the City of Kelowna, innovative strategies developed to address impacts of the fire on the community, and the development of mitigation strategies before and after the OMPF. The case study revealed drivers and barriers to mitigation works, as well as the impacts of institutional arrangements on various approaches to disaster mitigation.

Section 2 of this paper outlines the context of WUI hazards, the concept of resilience and disaster mitigation, and the role of municipal governments in disaster mitigation. This section also provides a discussion of common barriers to the implementation of disaster mitigation programs experienced at the local level. Section 3 provides a review of methods used in the study, and a review of the case study (City of Kelowna) and the OMPF. Section 4 provides results and discussion for this exploratory study, including discussion of response, recovery and mitigation strategies implemented by the City before, during and after the OMPF, general interviewee perceptions of wildfires and resilience, and barriers to mitigation. Section 5 discusses characteristics of resilience in the City of Kelowna's experience with the OMPF and provides recommendations and suggestions for further work.

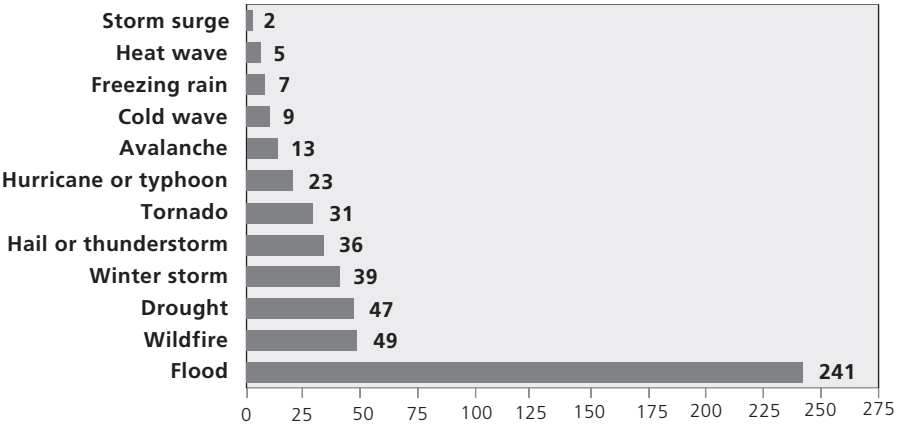
2. Context

2.1. Wildfires in Canada

In an average year in Canada, 2.5 million hectares are burned by 8,500 individual wildfires. The area burned by wildfires varies significantly from year to year. The majority of wildfires are human caused (approximately 60%), and the remainder are caused by natural events (i.e., lightning strikes) (NRCan, 2008).

Wildfires pose a significant risk to life and property in Canada. While monetary damages from wildfires have historically been eclipsed by those from other climatological and hydrologic hazards, wildfires are one of the most commonly reported disasters in Canada. According to the Canadian Disaster Database, a total of 49 wildfire disasters have been reported since 1900, the second most common natural hazard following flooding (Figure 1).

Figure 1: Reported number of disasters from 1900 to 2005



Source: Public Safety Canada, 2007a

Wildfires are natural events, and Canada's forests rely on wildfires as vital natural disturbances which maintain health, productivity and biodiversity in forest ecosystems (CFS, 2007). Many fires that burn during an average year occur largely in unpopulated forested areas, and often these wildfires are allowed to burn until they are extinguished through natural processes (NRCan, 2008). Management of wildland fires must balance both the benefits of this natural disturbance and the risks they pose to humans (Zaksek & Arvai, 2004). In instances where wildfires have the potential to affect human settlements or cause damage to valuable timber resources, fires are aggressively suppressed (NRCan, 2008). Fire fighting is one of the most expensive aspects of forest management in Canada, where approximately $400 to $800 million is spent by provincial/territorial governments and the federal government on forest fire fighting, including fire suppression, prevention and prescribed burning (NRCan, 2008).

[1] The Canadian Disaster Database includes events that have resulted in 10 or more deaths, 100 or more affected people (injured, evacuated, or left homeless), an appeal for national or international assistance, and/or a situation where significant damage/disruption of normal processes has occurred, such that the community affected cannot recover on its own. The Database also includes events that have a historical significance (Public Safety Canada, 2007).

Forest fires can result in significant economic costs, much of which are allocated to fire fighting. However, the total cost of forest fires can far exceed the costs of suppression, and include damages to timber stocks, damage to public and private infrastructure and property, and costs associated with disruption of business in affected communities (NRCan, 2008).

Researchers have argued that wildfires in Canada are affected by climate change. For example, climate change could result in a longer fire season, increases in the severity of fire weather (dry and windy conditions), more ignitions, and a higher amount of area burned from wildfires (Flannigan *et al*., 2005; Gillett *et al*., 2004). Gillett *et al*. (2004) identify an upward trend in area burned by wildfire in Canada over the past few decades, and argue that climate change has had a direct impact on this increase.

Wildfire suppression is a common method of managing forest fires in Canada. Forest fire suppression (or exclusion) can be defined as "human intervention to extinguish periodic, naturally occurring fires" (Filmon, 2004: 25). In Canada, almost 90% of wildfires are fought (NRCan, 2005a). As mentioned above, suppression activities require hundreds of millions of dollars every year in Canada. Though suppression activities have been extremely effective for the reduction of forest fires, it has been argued that the practice of suppression can lead to fuel build-up, which can exacerbate the severity of fires when they do occur (Zaksek & Arvai, 2004). However, it has been argued that the impacts of fuel build-up caused by wildland fire suppression depend on the nature of the forest ecosystem, some of which are more susceptible to build-up than others (Johnson *et al*., 2001).

Wildland fires have caused a number of civilian deaths in Canada. The most recent occurrence of civilian deaths was a 1938 wildfire in Dance Township, Ontario, which was caused by brush burning by local settlers, and resulted in 17 deaths (PSC, 2007a). Further, many fire management personnel have been killed as a result of fire management activities. Between 1986 and 2005, 34 fire management personnel were killed by the fires themselves, or through fire fighting activities (NRCan, 2008). The forest fires of 2003 in British Columbia resulted in the death of three pilots involved in fighting the forest fires (Filmon, 2004).

2.1.1. Wildfire damages

In Canada, natural events including flooding, high wind and hail storms are responsible for major insurance payout events (IBC, 2008). Historically, wildfire events have not often resulted in massive payout events. Only one severe wildfire event is listed in the IBC Facts Books, from 1983 to 2008: The 2003 British Columbia wildfire season, where $200 million in insured damages were incurred (IBC, 1998; 2008). However, the Public Safety Canada Canadian Disaster Database reports 49 wildfire events that have resulted in damages, from 1911 to 2005 PSC, 2007a). Many of these events have required the evacuation of a large number of residents, and have resulted in considerable damages to infrastructure and private property.

Internationally, wildfires do not result in the same level of damages as other natural hazards, including flooding, windstorms and earthquakes (Munich Re, 2006). In the United States, insured damages from forest fires are generally exceeded by other natural and human-caused hazards (Table 1).

Table 1: U.S. insured catastrophic losses from 1987 to 2006

Hazard	Total cost (Billions)*	Percent of total losses
All tropical cyclones[1]	137.7	46.3
Tornadoes	77.3	26.0
Winter storms	23.1	7.8
Terrorism	22.3	7.5
Earthquakes[2]	19.1	6.4
Wind/hail/flood[3]	9.3	3.1
Fire[4]	6.6	2.2
Civil disorders	1.1	0.4
Utility service disruption	0.2	0.1
Water damage	0.4	0.1
Total	**$297.3**	**100**

* Adjusted to 2006 US dollars

[1] Includes hurricanes and tropical storms
[2] Includes all geologic events (volcanic eruptions, earth movements)
[3] Does not include damages covered by the National Flood Insurance Program
[4] Includes structural and wildland fires

Source: Insurance Information Institute, 2008a

Though other hazards have resulted in greater damages, the costs of wildfire damages are still considerable. For example, there have been several damaging fire events in the US in the past 40 years. Four of the events, when adjusted to 2007 dollars, resulted in insurance payouts of over $1 billion each (Table 2). Further, the Witch Fire of 2007 resulted in the 5th highest insured loss event for a natural catastrophe in the world that year (Insurance Information Institute, 2008b).

Although wildland fires have not been the most damaging natural hazard in Canada over the past few decades, researchers have argued that risk may be increasing. For example, various impacts are expected to result from climate change, including a longer fire season, more severe fire weather, and more and larger fires (Gillett *et al*., 2004). As well, further risks may result from continued encroachment of development into wildland interface zones (McCaffrey, 2004), a lack of individual property owners' interest in mitigating their risk (Brenkert-Smith *et al*., 2006; Winter & Fried, 2000), resistance to effective wildland fire mitigation tools including prescribed fire, and a willingness to accept wildfire risk as a trade-off for living in forested areas and building with fire vulnerable materials (McCaffrey, 2004; McGee, 2007; Winter & Fried, 2000).

Table 2: Ten most catastrophic wildfire events in the United States

Date	State	Wildland fire	Estimated insured loss* (000)
Oct 1991	California	Oakland Fire	$2,597,445
Oct and Nov 2003	California	Cedar Fire	$1,194,228
Oct 2007	California	Witch Fire	$1,300,000
Oct and Nov 2003	California	Old Fire	$1,098,465
Nov 1993	California	Los Angeles County Fire	$537,976
Oct 1993	California	Orange County Fire	$502,111
Jun and Jul 1990	California	Santa Barbara Fire	$420,310
May 2000	New Mexico	Cerro Grande Fire	$168,537
Jun 2002	Arizona	Rodeo-Chediski Complex Fire	$138,277
Sep 1970	California	Oakland and Beverly Hills Fire	$132,757

* Adjusted to 2007 US dollars

Source: Insurance Information Institute, 2008c

The current Mountain Pine Beetle epidemic (McFarlane *et al*., 2006) will have many impacts on the forest system, including impacts on timber supply, loss of forest cover and associated impacts on habitat, impacts on hydrological functioning of forest ecosystems, and an increase in wildland fire risk (NRCan, 2005b).

2.2 Wildland-urban interface risk

Forested areas are often considered desirable places to live. Indeed, much development has been located in such areas, so as to allow inhabitants to enjoy the aesthetic value of forested surroundings (McCaffrey, 2004; Partners in Protection, 2003). Desirable areas often bring with them considerable risk from extreme natural events. For example, coastal areas bring hurricane risk and riversides bring erosion and flood risk. Forested areas, as well, bring the risk of the impacts of natural disturbances, including wildland fire.

Development that meets forested areas is commonly referred to as the Wildland-Urban Interface (WUI or interface). Partners in Protection (2003) defined the WUI as "any area where industrial or agricultural installations, recreational developments, or homes are mingled with natural, flammable vegetation" (Partners in Protection, 2003: front matter). Intermix areas are where development is intermingled with forests and other types of vegetation (McGee, 2007). Exposure to wildfire hazards is created by developing in WUI (interface and intermix) areas.

2.2.1. Wildland urban interface fire hazard management

Control of interface fire risk requires the participation of various levels of government and private individuals. The federal government can set the tone for emergency management, and encourage local governments to take mitigation action through research and funding for mitigation projects, and can manage fuel loads in national parks. At the landscape level, provincial authorities can work to manage fuel loads in Crown lands and help to coordinate response efforts through incident command processes. At the community level, municipal governments can manage interface risk within their own jurisdictions, by identifying and assessing hazard areas and managing land-uses in these areas. Municipal governments can also become involved in education, and develop covenants that require new developments to adhere to various building and development standards that can reduce fire risk (McGee, 2007). Individual property owners can also take substantial actions to reduce risk on their own property, for example, by managing fuel loads and using fire-resistant roofing materials (Partners in Protection, 2003). Responses to fire hazards can be categorized in terms of "*managing the hazard*" (managing the potential of fire occurring, or controlling the fire when it occurs) and "*managing behaviour*" (attempt to change the behaviour of those affected by fire risk, including lower-level governments and private individuals) and "emergency management" (managing the disaster emergency). The range of mitigative options is provided in Table 3.

Private homeowners have a substantial role to play in the mitigation of WUI fire risk. The FireSmart manual (Partners in Protection, 2003) provides guidance for individual property owners and communities to manage WUI risk on their own property. Specific recommendations for property owners include:

- Vegetation (fuel) management:
  - Management of fuel in areas surrounding buildings, prioritized based on distance from the building (first priority: 0 to10 metres, second priority: 10 to 30 metres, third priority: 30 to 100 metres);
  - Vegetation management approaches may include reduction and removal of flammable dead and live vegetation or conversion of vegetation to less flammable species;
  - Fuel management approaches may take the form of:
    - Fuel removal;
    - Fuel reduction, and;
    - Fuel conversions.
- Structural options:
  - Measures to be included in the design or retrofit of interface buildings to reduce fire risk;
  - Roofing materials that are prone to catching fire are discussed as the main cause of building loss during WUI fires; fire resistant roofing materials are encouraged;
  - Proper spacing and installation of spark arrestors on chimneys, fire-resistant siding materials, fire resistant windows and doors, reduction of fire exposure through eaves, vents and other openings, reduction of risk through proper design of balconies, decks and porches, and considerations for trailers and manufactured homes;
  - Onsite firefighting equipment (rooftop sprinkler systems, tools for handling/transporting water, tools for fire fighting in areas surrounding buildings.

Despite the range of options for individual property owners, adoption of these adjustments is not guaranteed. Research in public perceptions of risk has consistently revealed that individuals at risk tend to deny or denigrate the exposure, and therefore are often unwilling to adopt mitigative adjustments (Burton *et al*., 1993; Mileti, 1999). Studies on wildfire risk perceptions have identified a lack of awareness of risks associated with wildland fire among those living in WUI areas (Arvai *et al*., 2006). Further, residents inhabiting these areas are often resistant to fuel treatments, as fuel treatments interfere with the aesthetic value of forest landscapes (McCaffrey, 2004). Some studies suggest that as individuals commonly live in interface zones for the aesthetic value of the landscape, they are often unwilling to take other actions, including managing fuel on their own property. Individuals may also feel that efforts to manage fuel on their property are futile, due to the belief that wildland fire mitigation is beyond the control of humans (Winter & Fried, 2000). However, willingness to adopt fuel management on private

lands has been shown to vary based on geographic location, and some communities have been found to be more receptive of prescribed burns and different types of fuel management approaches (Brunson & Shindler, 2004; Manfredo *et al.*, 1990). As shown in Table 3, municipal governments are often directly involved in education programs to encourage individuals to uptake and support various mitigation options.

Table 3: WUI fire management by level of government

Level of government	Manage the hazard	Manage the behaviour	Emergency management
Federal	• Research • Manage fuel in National Parks	• Research • Building codes	• Set context for emergency management in Canada • Disaster recovery assistance (DFAA) • Assist with emergency preparedness (JEPP) • Emergency management training
Provincial	• Manage fuel loads on public lands and parks, particularly adjacent to urban areas • Promote general forest management and forest health • Fire suppression • Coordinate fire suppression resources • Support local emergency management • Manage post-fire hazards (e.g., hydroseeding)	• Encourage regional and municipal governments to undertake fuel management • Assist in the identification of WUI areas • Building codes • Inform public of fire risk (danger ratings) • Land management • Foster awareness at the local government level • Fire restrictions • Public education	• Set emergency management legislation for local governments • Financial disaster recovery assistance • Engage local authorities in emergency management procedures (e.g., unified command) • Assist local authorities with emergency management responsibilities • Travel restrictions at times of high risk • Coordinate JEPP
Local (Regional or Municipal)	• Fuel management within their jurisdiction, construction of fire breaks • Identify WUI hazard areas • Cross-agency training, preparedness of suppression activities • Pick-up and dispose debris (fuel) from private properties	• Engage public in hazard mitigation (e.g., FireSmart dissemination, education programs) • Land-use planning, managing and restricting development in hazard areas • Legislation (building covenants, bylaws) • Inform public of immediate risk • Local burning restrictions • Assist in evacuation notices	• Develop, implement local emergency program • Emergency response • Structural firefighting • Recovery assistance, managing recovery resources, disbursement of provincial recovery resources • Cross agency training, preparedness • WUI fire/emergency management infrastructure, including hydrants, water supply, evacuation routes, road design, general subdivision design

Sources: Auditor General, 2004; McGee, 2007; McGee et al., 2005; Partners in Protection, 2003; PSC, 2008a; NRCan, 2007

Social science research on wildfires in Canada is limited. Although there has been some progress made in the examination of public attitudes, perceptions and behaviours regarding wildfires in the U.S. and Australia, models developed in this research have largely not been applied in Canada (McGee *et al*., 2005). To date, few studies (Arvai *et al*., 2006; McGee, 2007; McGee *et al*., 2005) investigating public and community leader perceptions of wildfire risk in Canada have been completed.

2.3 Resilience

Resilience is commonly viewed as a desirable property of human systems, including cities, which may face multiple adverse stressors and shocks (Klein *et al*., 2003; Turner II *et al*., 2003). Shocks may come in a variety of forms, from direct physical shocks (e.g., environmental hazards such as chemical spills or natural disasters), to social and economic shocks (e.g., impacts on resource markets in single-resource dependent communities) (Greenberg *et al*., 2007; Klein *et al*., 2003). Generally, the concept includes the acceptance that some impacts from external shocks are inevitable. However, a resilient system will have the capacity to mitigate these impacts, and therefore quickly recover.

Resilience is a much debated term in the academic literature. Authors have argued that the origins of the term can be traced back to its application to ecosystem resilience, which was a measure of an ecosystem's ability to absorb changes and still persist (Holling, 1973; Klein *et al*., 2003). However, other researchers have traced the term back to its applications in psychology, psychiatry and physics (Manyana, 2006). More recently, the term has been increasingly applied as a process or end state of cities (Klein *et al* 2003). The term can be differentiated from the term "stability," as stability suggests an ongoing stable state, and cities that are affected by adversity rebound back to their original state before the adversity occurred. Resilience, on the other hand, reflects a dynamic state.

Though broadly debated, the term has practical applications for the abilities of human systems to withstand adversity. The concept of resilience has been applied to the individual (Manyana, 2006), communities of individuals (Kulig *et al*., 2007) and urban systems, or cities (Henstra *et al*., 2004). At the community level, economic resilience may be applied to understand how a community overcomes or endures economic hardship.

In the context of natural hazards, the following definitions of "resilience" or resilient systems are provided:

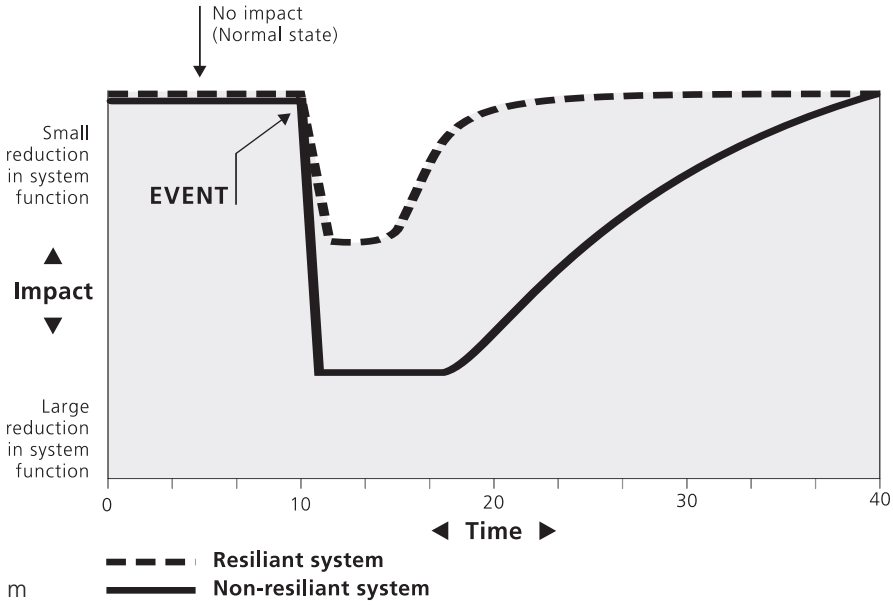
- Systems that undergo stress and have the ability to recover and return to their original state (Klein *et al*., 2003);
- A system's ability to bounce back to a reference state after a disturbance (Turner II *et al*., 2003);

- The capacity to adapt to stress from hazards and the ability to recover quickly from their impacts (Henstra *et al*., 2004);
- The coping capacity and ability to recover quickly from adverse impacts of disasters (McEntire, 2001);
- "Local resiliency…means that a locale is able to withstand an extreme natural event without a large amount of assistance from outside the community" (Mileti, 1999: 32).

All of these definitions incorporate an expectation of a hazard, and a level of impact from the hazard (from which to bounce back). Thus, the concept of resilience acknowledges that some disaster impacts will be inevitable; however, these impacts can be mitigated and overcome quickly. Figure 2 provides a simplified visualization of this concept.

The graph (Figure 2) depicts at first a normal state, intercepted by a hazard event, or shock (EVENT). At this point, both the resilient and non-resilient systems suffer some impacts, described here as a reduction in the system's ability to function. In the context of a municipal government, a reduction in system function may be interpreted as the reduced ability of the municipality to carry on its normal functions of providing services to its residents. The non-resilient system, as displayed in the figure, suffers a greater reduction in its function than does the resilient system. As well, the resilient system is able to return to normal functioning more quickly than the non-resilient system, due to both adequate planning for response and recovery and due to the mitigated hazard event.

Figure 2: Resilience



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Based on discussions by Henstra *et al*., 2004; Klein *et al*., 2003; McEntire, 2001; Mileti, 1999; Turner II *et al*., 2003

Godschalk (2003) provides a discussion of the importance of creating resilient cities through the practice of urban hazard mitigation. The author states that resilient cities would be designed in advance to

> anticipate, weather, and recover from the impacts of natural…hazards, resilient cities would be built on principles derived from past experience with disasters in urban areas (Godschalk, 2003: 136).

As well, resilient cities would learn from their own experience with disasters (Godschalk, 2003). Godschalk (2003) further discusses the role of resilient physical systems (infrastructure, etc.) in the resilience of a community. Godschalk (2003) suggests that research has identified characteristics of resilient systems, presented in Table 4.

Table 4: Characteristics of resilient systems

Characteristic	Description
Redundant	A number of functionally similar components so that the entire system does not fail when one component fails – a useful characteristic of critical infrastructure
Diverse	A number of functionally different components in order to protect the system against various threats
Efficient	A positive ratio of energy supplied to energy delivered by a dynamic system
Autonomous	Capability to operate independently of outside control
Strong (or resistant)	Possess the power to resist perturbations
Interdependent	System components connected so that they support each other
Adaptable	Capacity to learn from experience and the flexibility to change
Collaborative	Multiple opportunities and incentives for broad stakeholder participation

Source: Godschalk, 2003: 139

The characteristic of disaster resistance has been discussed as an important component of a resilient community. Resistance is the ability of systems (such as infrastructure) to resist the strain or force exerted by a hazard, and therefore suffer no impacts from a hazard event (Etkin, 1999; McEntire, 2001). This characteristic differs from resilience, as it suggests that the resistant system will be designed to suffer no damages or impacts associated with a hazard. Etkin (1999) states that "resistance refers to the capacity of society to withstand external forces without change, while resilience refers to its capacity to bounce back to a pre-disaster state" (Etkin, 1999: 74). An illustration of the differences are elaborated through an approach to flood mitigation at the individual home level, as proposed by the Association of British Insurers (2004). A home designed to resist flood impacts would be designed to prevent flood waters from entering the home, therefore resulting in no damages or impacts from flood events. A home that is resilient to flooding would allow flood waters to enter the home, however, would be designed in a manner that flood damages would be reduced and would allow for clean up or remediation to occur quickly. This can be done, for example, by the usage of tile flooring rather than carpeting (ABI, 2004; see also Garvin *et al.*, 2005). The same concept can be applied to infrastructure systems in communities. Etkin (1999) warns, however, that resistance is only a component of overall disaster resilience, as the precise nature (magnitude, duration, location, geographic extent, etc.) of natural hazards is unpredictable. This unpredictability results in an inability to account and design for all contingencies. Thus, resistance should be incorporated as a strategy to achieve resilience, rather than an end goal (Etkin, 1999; Godschalk, 2003; Henstra *et al.*, 2004).

2.3.1 Vulnerability to natural hazards

Natural disasters have traditionally been viewed as inevitable and out of the control of humans, and the role of humans in creating vulnerability to natural hazards was downplayed (Baum *et al*., 1983; McEntire, 2001). To manage disaster risk, practitioners applied strategies to control hazards to suit the development practices of humans. Thus, there was a strong focus on controlling hazards through application of engineering or structural approaches. A common example of this approach is the use of flood control structures, including dams and levees, to alter the characteristics of rivers and, to a certain extent, reduce flood risk. A parallel example of managing the hazard rather than managing human behaviour is suppression of all wildland fires that present a threat to human systems (communities, economies, etc.).

These views of natural disasters lead to a focus on hazards, rather than vulnerability. The terms are here defined:

- A *hazard* can be defined as: "A potential damaging physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation" (United Nations, 2004: Annex 1)
- *Vulnerability* is the propensity of a system (community, individual, ecosystem, etc) to suffer loss from a hazard event, or the degree to which a system is likely to experience harm from exposure to a hazard (Etkin, 1999; Turner II *et al*., 2003).

Research has revealed that the reliance on various approaches to control nature actually resulted in increased disaster risk, which has been discussed by various authors who have investigated the management of flooding in North America (White, 1945; Bruce, 1976). Early research in this area highlighted the role of humans in creating disasters, rather than a strict focus on hazards themselves.

The consideration of vulnerability in natural hazards management has increasingly included the role of humans in creating vulnerabilities to these hazards as a major agent in disasters. Disasters are now commonly viewed as the interaction of natural events (hazards, e.g. flooding and earthquakes) with human generated vulnerabilities (Henstra *et al*., 2004; McEntire, 2001; Turner II *et al*., 2003). While humans may have only limited control of natural events, they have considerable control of their vulnerabilities.

McEntire (2001) argues that vulnerability is largely comprised of four components: Risk; Resistance; Susceptibility, and; Resilience (Table 5).

Vulnerability is affected by several components. Füssel (2007) argues that vulnerability is affected by internal factors (factors within the vulnerable system), and external factors (factors outside of the vulnerable system) (Table 6). The distinction may be made based on geographic boundaries (e.g., a watershed), or on political boundaries (e.g., a municipality). Internal and external factors can further be categorized by knowledge domain, or by the traditions and disciplines that are applied to understand the factors.

Table 5: Components of vulnerability

Components that increase vunerability	
Risk	Proximity and exposure to hazards, affects probability and severity of loss
Susceptibility	Social, political, economic, cultural forces and activities, which affect proneness of individuals and groups to being adversely affected by a disaster
Components that decrease vunerability	
Resistance	Ability of infrastructure or systems to resist strain/force exerted by natural forces; total resistance to a hazard would require no resources for recovery
Resilience	Coping capacity, ability to react or effectively recover from disaster; accepts that disaster will occur and the system will sustain impacts, however impacts, and therefore recovery resources (economic resources, time, etc.), will be minimized or reduced

Source: Etkin, 1999; McEntire, 2001; Geis, 2000

Vulnerability factors that fall within the socioeconomic knowledge domain may include the socioeconomic characteristics of individuals within the vulnerable system (including their education level, household income, land tenure, family status), the institutional arrangements developed to manage vulnerability (e.g., emergency management legislation, disaster relief programs), the cultural characteristics of the population, economic circumstances, and so on. The factors studied within the socioeconomic knowledge domain are typically studied by the social sciences and humanities (Füssel, 2007). Factors within the biophysical knowledge domain are those that are typically studied by the natural sciences and engineering, including the natural characteristics of the local (internal) environment, or external climate and weather patterns (Table 6). Factors that lie within the socioeconomic knowledge domain have a greater potential to be controlled and managed by humans than those which lie in the biophysical knowledge domain. However, it is equally important to have a good understanding of the biophysical factors that affect vulnerability.

Table 6: Vulnerability categories and example factors

		Knowledge domain	
		Socioeconomic	**Biophysical**
Sphere	**Internal**	***Factors affecting individuals:*** • Household income & levels and concentration of wealth • Social capital/social networks • Individual risk perceptions/adoption of mitigative adjustments • Education levels ***Factors affecting the community:*** • Local government policies and institutional arrangements • Urbanization • Population density, size of population • Development in hazard prone areas • State of infrastructure • Dependence on technology • Local economic circumstances	• Topography • Local environmental conditions • Land-use patterns • State of infrastructure • Environmental degradation
	External	• Institutional arrangements at national and provincial level • External economic context • International influences	• Climate trends • Severe storms • Weather events • Climate change

Adapted from Füssel (2007); Sources: Cutter *et al*., 2000; Cutter *et al*., 2003; dedSherbinin *et al*., 2007; Dore, 2003; Etkin, 1999; Etkin *et al*., 2004; Field *et al*., 2007; Hebb & Mortsch, 2007; Shrubsole, 2000

Disasters and disaster payouts have been increasing significantly in Canada over the past few decades (Dore, 2003; PSC, 2007a). For example, Dore (2003) analyzed Public Safety Canada's national disaster database, and revealed a substantial increase in natural disasters, especially hydrometeorological disasters (wind events, drought, flood, etc., excluding geological hazards). In the 2004 assessment of natural hazards in Canada, Etkin et al. (2004) identified some of the general factors that have affected vulnerability to hazards in Canada, including population growth and density, concentration of wealth, inadequate land-use policies, aging populations, infrastructure issues, lack of knowledge about local biophysical vulnerability issues, lack of standards enforcements (e.g., building codes), and issues with monitoring systems.

An understanding of all aspects of vulnerability is important in the reduction of natural hazard damages.

2.3.2 Resilience to natural hazards: Disaster mitigation

Disaster resilience can be largely achieved through the implementation of various disaster mitigation initiatives (Godschalk *et al*., 2003). As Tobin (1999) states, "…it is through mitigation programs that exposure and risk are reduced" (pg. 14). Vulnerabilities are therefore reduced through the implementation of mitigation strategies, and resilience is increased. Mitigation can be defined as "sustained actions to reduce or eliminate the long-term impacts and risks associated with natural and human-induced disasters" (OCIPEP, 2002: 2). Measures for mitigation are generally categorized in the structural and non-structural, and may include:

- Structural measures:
  - Structures designed to affect the hazard and reduce risk to human populations, for example flood walls, levees, etc.
- Non-structural measures: generally designed to affect human behaviour and reduce risk of damages:
  - Measures may include reducing exposure to hazards through land-use planning, increasing public awareness, and managing human behaviour to reduce exposure to hazards.

All stages of emergency preparedness are essential to a resilient community (Table 7). Response and recovery are relatively well defined strategies in Canadian emergency preparedness. At the municipal level, structural (urban) fire fighters, police and emergency medical services are well established and highly effective emergency management strategies. In many provinces, including British Columbia, local municipalities are legislated to have appropriate emergency preparedness plans. Recovery is a well established emergency management strategy, and all levels of government across Canada have been involved in cost-sharing initiatives to ensure disaster stricken communities are able to return to their pre-disaster state as quickly as possible. However, disaster mitigation has not been as extensively implemented in Canada (OCIPEP, 2002). The overall goal of community disaster resilience can largely be achieved through the implementation of mitigation strategies, which aim at reducing vulnerabilities to hazards.

Table 7: Components of emergency management

Emergency management component	Description
Mitigation (mitigation/prevention)	Sustained actions to reduce or eliminate the long-term impacts and risks associated with natural and human-induced disasters
Preparedness	Planning for response and recovery; developing policies, procedures, and plans for managing emergencies
Response	Actions taken immediately before, during or after an emergency occurs (e.g., first responders)
Recovery	Efforts taken to repair and restore communities up to an acceptable level

Sources: Gazdik, 2007; NFPA, 2007

Disaster mitigation is viewed as the most sustainable way to manage natural hazards (Mileti, 1999), and effective natural hazard mitigation should include a mixture of structural and non-structural adjustments. Mitigation is the most effective way to achieve resilience, as it is focused on reducing vulnerabilities to hazards; mitigation is focused on treating the source, rather than the symptoms.

2.3.2.1 Pre- and post-disaster mitigation

Disaster mitigation can further be reduced into pre- and post-disaster mitigation. Pre-disaster mitigation seeks to manage hazards before they occur, through applying risk assessment and treatment options. Post-disaster mitigation occurs after a disaster. This is the most common type of mitigation, as communities are most aware of their vulnerabilities to hazards immediately after experiencing a disaster.

2.3.2.1.1. Pre-disaster mitigation

Designing our communities in a manner that incorporates resilience to all types of hazards (including natural) is the preferred means of mitigating natural disaster risk. Our vulnerability to natural hazards can be significantly reduced through pre-disaster mitigation planning, and integration of natural disaster mitigation in all aspects of urban development (Quarantelli, 1989; Tobin, 1999). Certainly, the term "hazard mitigation," in and of itself, describes strategies that are employed during the pre-disaster period to reduce the impacts of hazards when they occur.

Hazard identification is an essential element to community-level emergency management, and communities in British Columbia must develop emergency management plans which reflect hazard risk identification and analysis (PEP, n.d.). In British Columbia, local hazard assessment is mandated by the *Emergency Program Act* (British Columbia, 1996) and can be completed through the Hazard, Risk and Vulnerability Analysis (HRVA) process. The HRVA toolkit, developed by the Provincial Emergency Preparedness Program (PEP, 2003), describes that the HRVA process is designed to "help a community make risk-based choices to address vulnerabilities, mitigate hazards, and prepare for response to and recovery from hazard events" (PEP, 2003: i). Assessment of hazard risks is a common requirement of communities in Canada, with the purpose of enhancing local level emergency preparedness. Generally, provincial governments create legislation that mandates certain action at the local level, and may produce aids for local governments to carry out hazard analyses. It is generally up to the local authority to carry out hazard assessments, and act on mitigation strategies for their local hazards.

Historically, the federal government has supported hazard identification through the National Flood Damage Reduction Program (FDRP), which was focused on the sharing of expertise and costs between local, provincial and federal governments fo the development of flood hazard identification maps (and has now been wound-down) (Watt, 1995). Maps were then used in part to restrict and manage development in hazard prone lands. This strategy was identified as extremely effective (de Loë & Wojtanowski, 2001). A study by Brown *et al*. (1997) compared damages in Michigan and Ontario, where the State of Michigan was less progressive in managing development in floodplain areas. In a situation where both these areas were subject to similar flooding events, damages in Ontario were approximately 1000 times less than those in Michigan. This difference was attributed to the pre-disaster management of development in floodplain areas in Ontario, where development in these risk areas was more highly controlled than in Michigan (Brown *et al*.,1997)

The risk management approach to natural hazards management requires a focus on hazards during the pre-disaster period (Sandink, 2007). Risk based choices include evaluating the impacts and consequences and placing priority on and allocating resources to the risks that pose the greatest threat first. In the context of the multiple responsibilities and priorities of government at the local level, as well as limited resources, prioritization and management of the greatest risks would be an essential approach for natural hazard management.

A risk-based approach is important for climate change adaptation, as many of the historical standards used to manage natural hazards may not necessarily reflect future likelihood of occurrences of natural hazards. For example, with a doubling of CO2 in the atmosphere (estimated to occur by 2070), some hazards that are currently considered 1 in 100 year events could occur as frequently as once every 10 to 15 years (Lehner *et al*., 2006). Several agencies, both within Canada and internationally, have begun producing climate change adaptation literature that espouses the components of effective risk management, including identification and analysis of the potential impacts of future climate scenarios (Willows & Connell, 2003; Challenor, 2006; Mehdi, 2006; Snover *et al*., 2007). Agencies in Australia and New Zealand have commonly been identified as some of the more progressive adaptors and innovators in the risk management fields, and government based agencies in these countries have begun to adopt (or at least advocate) a risk management approach to climate change (Australian Greenhouse Office, 2006; New Zealand Climate Change Office, 2004). The pre-disaster mitigation and risk based approach will become an important component of managing disasters in a changing climate.

While pre-disaster mitigation may be the preferred approach to disaster mitigation, and a risk based approach may be a requirement in the context of increasing disaster frequencies and severities as a result of climate change, support for this approach is lacking in Canada (Henstra & McBean, 2004; Hwacha, 2005). The approach is recognized in some parts of the world. For example, the Pre-Disaster Mitigation program has been established by FEMA (USA) to assist communities in the development of disaster mitigation initiatives in the pre-disaster period (FEMA, 2007). Though there is a history of support for pre-disaster mitigation initiatives at the federal level in Canada, no federal pre-disaster mitigation program currently exists. It is far more common for communities to take action to mitigate disasters in the post-disaster period, as vulnerabilities and exposures to hazards have been clearly identified, and political and public support for hazard mitigation is enhanced during this time period.

2.3.2.1.2. Post-disaster mitigation

Pre-disaster mitigation is a preferred strategy in a disaster resilient community. Nevertheless, disasters or hazard events can effectively reveal vulnerabilities and focus public and political attention on disasters, their impacts, and possible solutions. Disaster events act as a trigger of vulnerabilities that have developed

within a system. Disaster events, however, can also act as a trigger for improved disaster management, through identification of vulnerabilities and weaknesses in the system. For this reason, it is important that communities effectively use the post-disaster period strategically for the implementation of mitigation strategies.

It has been argued that, of the four phases of disaster (mitigation, preparedness, response and recovery), the recovery stage is the least studied and least understood (Berke *et al*., 1993; Dash *et al*., 2007). However, the recovery stage provides substantial opportunity to directly increase the resilience and sustainability of a community. Support for hazard mitigation is often strongest during the "window of opportunity" that follows hazard events (Berke *et al*., 1993). During the recovery and rebuilding process, communities can implement rebuilding, repair and planning practices that can increase resilience, in comparison to pre-disaster situations (Berke *et al*., 1993; Mileti, 1999). As well, researchers have identified that during the long term recovery phase of a disaster, communities can work to increase their resilience to future disaster events (Reddy, 2000). Further, a key component of resilience is the ability to change and adapt based on new disaster experiences. Drabek and Hoetmer (1991, cited in Reddy 2000) argue that recovery during a post disaster situation should include reconstruction of the built environment, qualitative improvements in community life, and usually includes rebuilding of infrastructure and damaged structures, evaluation of codes and land use regulations, and adoption and implementation of hazard mitigation measures.

Post disaster policy windows can lead to extensive policy reviews, such as the 2003 Filmon Review in British Columbia which investigated various factors that should be improved following the firestorm (Filmon, 2004). Reviews and adaptation of wildfire management strategies can also be viewed at the municipal level. Adaptation of mitigative options was revealed in communities in Alberta following the Lost Creek wildfire in 2003. The progression of community level actions, as discussed by McGee *et al*. (2005) is presented in Table 8.

The study revealed that very few community level wildfire mitigation actions had been adopted before the occurrence, and an increase in adoption of mitigative adjustments in the post-disaster period (McGee et al., 2005). Rather, the communities focused on emergency response and fire suppression. As well, there was limited public education on fire risk and risk mitigation before the fire, and land-use planning through zoning and standards on how buildings could be built were not in place before the fire (McGee et al., 2005). During the fire, the communities focused on sprinkler systems and fire guards as damage mitigation actions (McGee et al., 2005). There was a progression of adjustments through the pre-fire stage, the response stage (during the fire) and the post-wildfire stage (Table 8). Following the fire, community level adjustments increased, and private individual level adjustments increased moderately (McGee et al., 2005). The study also discussed building code requirements in one community that required the installation of metal roofs. Though it was believed that this requirement was primarily designed to reduce risks associated with heavy snow loads, it would also have served to reduce wildland fire risks (McGee et al., 2005).

Table 8: Progression of community level wildfire mitigation adjustments during the Lost Creek Fire

Mitigation options	Pre-wildfire	During the wildfire	Post-wildfire
Vegetation Management	• None	• Fireguards	• Community Plan
Public Education	• Minimal	• House risk assessments • Residential FireSmart	• Residential FireSmart
Managing structural risk	• Minimal	• Sprinklers	• Review bylaws
Legislation	• None	• None	• Review acts

Adapted form McGee *et al.*, 2005

Implementation of recovery strategies during post disaster periods may be supported by higher levels of government. Even in situations where programs from higher levels of government may not support mitigation during the post-disaster period, evidence suggests that communities may have the capacity to influence recovery funds so that they support mitigation. International approaches to emergency management may require a local level government to implement mitigation measures during a post-disaster period. The United States' National Flood Insurance Program (NFIP) mandates certain levels of mitigation once a community has suffered damages from flooding. For example, if buildings in a community participating in the NFIP suffer certain levels of damages (50% or more of its market value), the structure must then be raised above the base flood elevation when it is reconstructed (Reddy, 2000). The NFIP has several other requirements that are designed to increase the resilience of specific structures during reconstruction following a flooding event (Reddy, 2000). Berke *et al*. (1993) report an instance where a community persuaded higher levels of government to allow for disaster recovery funds to aid in community development, including policies designed to allow for changes in permitted land uses and urban design standards. Incorporating community improvements as part of the disaster recovery process was facilitated by the existence of a plan before the disaster occurred, which provided a basis for the use of disaster relief funds and allowed local representatives to control funding to ensure their needs were met (Berke *et al*., 1993). Berke *et al*. (1993) further argued that communities have had difficulty in directing funds for other aspects of emergency management aside from recovery because they did not have a clear plan of how those funds should be used during the post-disaster period. Thus, in situations where higher levels of government may not support mitigative actions in the post-disaster period, clearly defined plans prepared in the pre-disaster period may aid local governments in securing funds for mitigation activities.

Private property owners can play a substantial role in post-disaster mitigation efforts, and increased adoption of adjustments by individuals following disaster experiences has been studied extensively. It has often been revealed that, after an individual property owner has sustained damages by a specific event, property owners may be considerably more likely to adopt mitigative adjustments to reduce their risk of sustaining damages during future events (Burton et al., 1993). This finding is true for many different types of hazards, including hurricanes, flooding and wildland-urban interface fires (Laska, 1986; McGee et al., 2005; Yoshida & Deyle, 2005). This willingness, however, may be short-lived as individuals begin to resume their lives and disaster preparedness drops off of their list of priorities. Some studies have revealed that experience with hazards may have no impact on disaster preparedness (Rustemli & Karanci, 1999). It has also been revealed that, in some cases, experience with a

hazard may decrease individual willingness to adopt mitigative adjustments. This phenomenon has been referred to as the "gambler's fallacy" (Burton et al., 1993) and also as the "post-disaster let down" (Arvai et al., 2006). These theories suggest that individuals perceive a lower risk of future events after they have experienced a recent event. A common misconception that is discussed in the literature is the individual/public perception of a 1 in 100 year disaster event (Burton et al., 1968). Individuals may believe that if they have experienced a 1 in 100 year event, that the likelihood of experiencing another event will be nil for the next 99 years (that is, they believe that disaster events are self-correcting). It has been argued that this fallacy may decrease perceptions of risk and therefore mitigative behaviour in the public. Thus, ensuring proper communications with private residents during the immediate post-disaster period to ensure that the random nature of many hazards is not misinterpreted is an important component of the post-disaster mitigation process.

The impact of disasters on increasing mitigative adjustments has also been identified for communities and community leaders. Solecki and Michaels (1994) argued that following significant disaster events, disaster related policies encounter a period of increased public and political interest and support. A policy window is defined as "transitory opportunities [where] the likelihood of adopting new policy or legislative proposals is greater than usual" (Solecki and Michaels, 1994: 587). New policy adoption and policy changes are facilitated by events which focus attention on a specific policy related issue (such as a hurricane), and then are promoted by "policy entrepreneurs," or those who are specifically interested in promoting the policy or policy change (Solecki & Michaels, 1994). Solecki and Michaels (1994) further argue that whether or not a policy change takes place is largely dependent not only on the event that sparks interest, but in many other contextual variables, such as the general mood of the country at the time (for example, a focus on safety).

Policy windows are often temporary and do not necessarily ensure that hazard mitigation actions will be adopted (Solecki & Michaels, 1994). In some circumstances, policy windows can fade quickly as public and political attention focuses on recovery processes, and returning a community back to normal (Henstra and McBean, 2005; Solecki & Michaels, 1994). Further, it has been argued that post-disaster policy windows may focus attention on already existing response and recovery issues, and may not necessarily focus attention on mitigation or loss prevention strategies (Solecki & Michaels, 1994). For example, communities that define hazard management as having only preparedness and response components may not have the capacity to improve actions related to mitigation during the post-disaster window of opportunity (Solecki and Michaels, 1994).

Post-disaster windows of opportunity would be effectively exploited by resilient, adaptable communities. These windows or time present opportunities for increasing mitigation efforts by individuals and governments, and can help to foster more resilient communities. However, these windows of opportunity do not guarantee adoption of effective mitigation measures. Individual perceptions may not accurately reflect reality, and a certain level of pre-disaster preparation and ingenuity may be required by governments to ensure that these windows are effectively exploited.

2.4. Disaster mitigation at the local level

Local governments bear the most direct and severe impacts of disaster events. It is local governments that provide the first responders, are directly involved in reconstruction and have experienced direct damage to infrastructure and must deal with the loss of lives and property (Reddy, 2000). As well, many of the most effective hazard mitigation tools are applied at the local level, including local building code by-laws, public education programs, and land-use planning practices (Steelman, 2007).

In Canada, local (municipal and regional) governments are responsible for emergency management within their jurisdictions. This includes the management of interface fire risks on public and private lands within the local government's jurisdiction (McGee, 2007). Many municipalities, especially since the 2003 fire season in British Columbia, have been working to introduce various interface fire mitigation strategies within their jurisdictions, including zoning to control and restrict development in wildfire-prone areas, planning covenants that specify building materials and fuel management requirements, and public education programs to inform residents of their role in managing interface fire risk (McGee, 2007).

Encroachment on disaster prone lands has long been identified as a major factor in the cause of damages from natural hazards, including flooding and wildfires (Bruce, 1976; Burby, 1998). In Canada and the United States, it is frequently the local level of government that has primary responsibility for land-use management. Land-use management has often been cited as one of the most (if not the most) effective means of controlling exposure to natural hazards (Burby, 1998; Shrubsole, 2000).

Municipalities in Canada have an important role to play in the mitigation of wildfire risk. For instance, municipalities can create and enforce building code bylaws and zoning bylaws, and they can conduct public education programs for both permanent residents and seasonal visitors. Wildfire perception literature often purports the disadvantages of taking a "one-size-fits-all" approach to homeowner mitigation education Bright & Burtz, 2006; Brunson & Shindler, 2004). Education programs designed by local municipalities can better reflect local attitudes and values regarding homeowner mitigation, community mitigation, and attitudes and beliefs about fire suppression and management mechanisms.

Municipalities can also take an active role in promoting structural mitigation mechanisms by providing homeowner incentives. As an example of successful homeowner damage reducing incentives, several municipalities in Canada have taken homeowner incentive actions to reduce basement flooding, and have shown considerable success with these programs. Municipalities can also foster a culture of awareness and preparedness through ongoing education and communication programs.

Despite the importance of local government in the management of natural hazard risks, studies have revealed a lack of adoption of programs and strategies related to hazard mitigation at this level. In a survey of 94 Ontario regional, county and municipal governments, Newton (2003) revealed that only 14% of responding communities had a natural hazard mitigation program, and that the majority of responding communities had not considered natural hazard mitigation in their planning procedures. Of the communities that did have a natural hazard mitigation plan in place, the author surmised that many of these plans were reactive, and based on previous hazard experience (Newton, 2003).

McGee *et al*. (2005) found that very few community-level activities had been implemented before or during the 2003 wildfires in southern British Columbia and Alberta. Prior to the fires, the focus of wildfire management was on emergency planning and activities related to fire suppression, as well as limited public education programs (McGee *et al*., 2005). Less than half of the residential respondents indicated that they received information before or during the fires, and there was no indication in the study that municipalities were a significant source of information on mitigative actions (McGee *et al*., 2005). However, McGee *et al*. (2005) attributed better knowledge of risk reducing activities in the Alberta community to FireSmart workshops provided by the local municipality. Generally, McGee *et al*. (2005) found that municipalities played a very small role, if any, in providing information to residents before and during the 2003 Lost Creek, AB and McClure, BC fires, and recommended an increase in research that investigates the institutional factors that impact community level mitigation mechanisms.

Disaster mitigation is an essential component of resilience at the municipal level, and pre-disaster mitigation is the preferred means of controlling hazard risk in resilient communities. Considering the apparent low rate of uptake of mitigation strategies in many municipalities in Canada, it is important to understand the context created by provincial and federal governments, and barriers to the implementation of disaster strategies at the local level in Canada.

2.4.1. Disaster mitigation assistance at the provincial level in British Columbia

In Canada, responsibility for disaster management is shared by all three levels of government. Public Safety Canada is responsible for coordinating emergency preparedness amongst the various federal departments and maintains operational links with provincial and municipal governments (Henstra & McBean, 2005; Hwacha, 2005). The majority of disasters fall under provincial jurisdiction, and British Columbia has established the Provincial Emergency Program (PEP) within the Ministry of Public Safety and the Solicitor General to take the lead role in disaster management. Generally in Canada, those located closest to an emergency are considered to be in the best position to manage those emergencies (Hwacha, 2005). Thus, local authorities are delegated responsibility for emergency management by provincial governments. Emergency management in Canada is largely focused on planning, response and recovery, and provincial and federal governments in Canada are largely not involved in assisting municipalities in any way with disaster mitigation and prevention (Henstra & McBean, 2005; Hwacha, 2005).

Assistance for mitigation measures from higher levels of government is a recognized factor in the ability of local authorities to uptake such measures. As disaster mitigation is an essential component of resilience, assistance from higher levels of government has consequences for the adoption of resilience related policies at the local level. Here, programs, acts and regulations at the provincial level (British Columbia) and federal level are reviewed, with a focus on components that assist local authorities in mitigation. The review revealed limited assistance at the provincial and federal level for mitigation and prevention at the local level.

2.4.1.1. Mitigation in provincial acts and regulations

British Columbia acts and regulations associated with emergency preparedness are largely focused on response and recovery. However, there are some sections which directly relate to mitigation and prevention of disasters.

The *Emergency Program Act* (1996) of British Columbia and its associated regulations define the duties and responsibilities of the provincial government (including the Provincial Emergency Program) and local authorities (regional and municipal authorities) for the development of emergency plans. T*he Local Authority Emergency Management Regulation* (1995) within the British Columbia *Emergency Program Act* (1996) delegates responsibility for the preparation of emergency management plans to local authorities, including aspects associated with emergency prevention and mitigation.

Under the *Emergency Program Act* (1996), local authorities are responsible for the provision of local emergency plans, which include preparation for, response to, and recovery from emergencies and disasters. While the emphasis of the *Act* is on response to, and recovery from disasters, some aspects of the *Act* indicate provincial powers to assist in mitigation at the local level. For example, the *Act* states that the powers and duties of the minister include making "payments and grants, subject to any terms or conditions that the minister may impose, to local authorities for the purposes of assisting in emergency prevention, preparedness and response" (Section 4(1)c).

The *Emergency Program Act* (1996) also describes government roles for disaster assistance funding. The parameters for the provision of disaster assistance are further developed in the *Compensation and Disaster Financial Assistance Regulation* (1995). The *Compensation and Disaster Financial Assistance Regulation* describes eligibility for disaster financial assistance for private citizens, farms and small businesses and local government bodies. Some provisions within the *Regulation* allow for limited disaster mitigation measures, and some provisions suggest requirements for mitigation measures.

The *Regulation* allows for some mitigative adjustments, specifically directed toward relocation of facilities. For example, section 25 (2) states:

> …if a public facility is damaged or destroyed in a disaster and in the opinion of the director retention of the public facility on the land on which the public facility stood before the disaster constitutes a danger to public safety or to the provision of essential local services, the Provincial Emergency Program may accept a claim for that public facility for an amount equal to the lesser of:
>
> a. the cost to relocate the public facility and to repair it to the condition it was in immediately before the disaster, and;
> b. the assessed value of the facility.

However, relocation of the public facility does not include provisions for costs to purchase the land on which the facility is to be relocated (Section 25 (3)).

Mitigation requirements exist for repeated claims. Under the *Regulation*, if governments have made more than two claims for a facility in a disaster prone area, they must show that they have taken adequate corrective or preventative action "that could have reasonably been taken" to avoid recurrence of similar damages (section 29). As well, facilities located in lands that were designated as floodplains and were built after those lands had been designated as floodplains, are not eligible for disaster assistance funding unless they had been appropriately flood proofed (section 30). As well, if it is determined that the claimant did not take sufficient action to protect the facility before the damage occurred, assistance provided following an accepted claim may be reduced or denied (Section 31).

However, it remains clear that the program does not provide assistance for upgrading facilities so as to reduce their vulnerability to hazards. Generally, the *Regulation* indicates that disaster assistance for recovery is designed to return facilities back to their pre-disaster condition.

Emergency management planning is delegated to local authorities in British Columbia, and is largely focused on planning (preparations), response and recovery. Although there are various sections within both the *Emergency Program Act* and the *Compensation and Financial Disaster Assistance Regulation* which relate to disaster mitigation, these sections are limited to post-disaster mitigation. Similar to approaches in other provinces in Canada, and of the federal government, the emphasis of emergency management in British Columbia is on the post-disaster period, rather than proactive vulnerability reduction.

2.4.2. Local level mitigation assistance at the federal level

For the purposes of the Kelowna case study, it is relevant to explore linkages between the federal government and local governments related to financial assistance for emergency management. Two programs at the federal level allow for transfer of funds from the federal level to the municipal level, however, municipal governments must work with or through provincial governments to access these funds. At the time

of the OMPF, there was no assistance for local level governments for mitigation measures. This section reviews two disaster related funding programs that are available from the federal government. As well, a brief review of the revised DFAA and the movement toward a mitigation strategy at the federal level are discussed.

2.4.2.1. Joint emergency preparedness program

The federal government, over many years, has encouraged disaster preparedness at the provincial and municipal government levels (Henstra & McBean, 2005). Since 1980, the federal government has administered the Joint Emergency Preparedness Program (JEPP), which was designed to assist provincial and territorial governments, and through them, local governments in the development of disaster preparedness projects (Henstra & McBean, 2005; PSC, 2007b). The JEPP may share costs, up to 75% of a project, not exceeding $3 million for a specific project (PSC, 2007b). The JEPP does not specifically rule out assistance for mitigative or preventative actions (aside from siren based public warning systems). However, JEPP is designed to assist in the funding of projects that have "a clear objective aimed at enhancing national civil preparedness for emergencies or critical infrastructure protection" (PSC, 2007b) and the program has focused specifically on increasing local level capacity to respond to disaster events (Shrubsole, 2007). While the program may assist communities in the development of projects related to emergency preparedness, the program deals directly with provincial or territorial governments and local communities must work through those governments to access funds (PSC, 2007b).

2.4.2.2. Federal disaster financial assistance arrangements

In the event that a provincial or territorial government requires resources beyond their own capacity during disaster response and recovery, the federal government may provide financial assistance to the provincial or territorial government through the Disaster Financial Assistance Arrangements (DFAA) instrument. The DFAA will provide assistance to provincial and territorial governments when recovery costs exceed the DFAA population threshold – i.e. when recovery costs exceed $1 per capita for that province or territory. Examples where the DFAA provided assistance include flooding in Alberta in 2005, the Manitoba Red River flood of 1997, and the severe wildfire season in British Columbia in 2003. As recovery costs increase for a province or territory, the federal government, through DFAA, will absorb a proportionately larger share of the costs (Table 9).

Table 9: DFAA funding shares

Spending per capita of provincial population	Federal share	Provincial share
$0-$1	0%	100%
$1-$3	50%	50%
$3-$5	75%	25%
$5+	90%	10%

Source: PSC, 2008a

Provinces and territories are responsible for the development and implementation of disaster recovery assistance programs, and decide when disaster payments are provided and the amount that will be provided within their jurisdictions. In the event that federal funding is approved, the DFAA provides funding directly to provinces and territories, and it is the responsibility of the province or territory to allocate DFAA funding for disaster victims and damages as they see fit. However, before 2008, no funding would be provided through the DFAA for mitigation.

Previous to the amendments made in 2008, the DFAA stated that "the purpose of the arrangements is to assist individuals and governments to restore essential private and public property to its pre-disaster conditions" (PSC, 2007c). Thus, the program provided partial assistance for recovery only, and was not designed to assist any level of government in the implementation of mitigation strategies.

2.4.2.3. NDMS and revised DFAA

The significant damages caused during the 1996 Saguenay River flood, the 1997 Red River Flood, and the 1998 eastern Canada ice storm, resulted in an average payout of $366 million in disaster assistance through DFAA for the three disasters (Hwacha, 2005). By comparison, before 1996, no one disaster claim paid out by DFAA exceeded $30 million (Hwacha, 2005). Reflecting these spectacular payout events, and recognizing the fact that payouts for such events could increase, in 1998 and in 2002 PSEPC held national consultation meetings to facilitate the development of a National Disaster Mitigation Strategy (NDMS) (Hwacha, 2005; OCIPEP, 2002). Through stakeholder deliberations, the need to re-orient Canada's response-focused emergency management culture was identified. Deliberations called for a disaster-prevention culture, in which pre-event disaster mitigation would be a significant component (Hwacha, 2005). The purpose of the strategy was to support mitigation, to build on the current "modest" investments made in disaster mitigation by governments at all levels (Hwacha, 2005: 521) and to provide a method to enhance the current piecemeal approach to disaster mitigation in Canada. The NDMS was also meant to foster a shared responsibility for disaster prevention amongst all levels of government, and part of the initiative included identification of disaster mitigation efforts taken at regional and local levels (Hwacha, 2005). It was suggested that the NDMS should also be linked with the DFAA, so as to incorporate disaster mitigation into relief funding. Furthermore, the need for the provision of financial incentives, and the lack of resources of local authorities to become involved in disaster mitigation, was acknowledged (Hwacha, 2005).

In January 2008, a strategy document, entitled "Canada's National Disaster Mitigation Strategy" was released by Public Safety Canada (PSC, 2008b). As well, a revised set of guidelines for the DFAA were released. The strategy document sets out guidelines for a mitigation strategy at the national level. However, the NDMS does not currently represent a formal policy or arrangement.

The DFAA in its present form is in many ways similar to the previous program, as it is aimed at returning damaged property and infrastructure for private individuals, small businesses and the public sector to pre-disaster condition. However, the revised program allows a mitigation supplement of 15% of total disaster recovery payouts to be provided to provinces, aimed directly at mitigating the impacts of future hazard events.

To qualify for funding, mitigation enhancements must be proposed by the province, and are subject to the approval of the federal government on a case-by-case basis. The revised program will also support "innovative recovery solutions," which will reduce or prevent the recurrence of damages and can be incorporated or undertaken for the same costs as restoration of damaged property, plus the 15% mitigation supplement.

Despite recent changes to disaster recovery programs, disaster mitigation at the federal level has historically been poorly supported (Henstra & McBean, 2005; Hwacha, 2005). The majority of responsibility for mitigation appears to still fall on the local authority. Furthermore, alterations made recently to the DFAA would not have been available to the City of Kelowna during and after the OMPF.

2.4.3. Barriers to resilience and mitigation at the municipal level

Though comprehensive disaster mitigation and resilience plans are likely a desirable goal for all communities, actual implementation of such strategies remains elusive (Tobin, 1999). Local governments deal with a plethora of various issues on a day-to-day basis, each with varying levels of urgency. These issues involve a variety of stakeholders, each with their own perceptions and values (Tindal & Tindal, 2004). As extreme natural events are, by definition, relatively rare occurrences, day-to-day community issues can divert attention from disaster mitigation issues (Henstra & McBean, 2005), and disaster mitigation issues are often only addressed in the wake of a significant disaster event.

It has been argued that at the local government level, the costs and benefits associated with the implementation of disaster mitigation tools may not be fully appreciated, and therefore local mitigation if often employed only when an imminent threat is perceived (Henstra & McBean, 2005). Further, it is often difficult to analyse the potential impacts of a disaster event. As well, the benefits of implementing a resilience strategy for a rare event may not be experienced over an extended amount of time. These factors make it difficult to garner public and political support for extensive mitigation measures.

Reddy (2000) investigated barriers to the implementation of mitigative actions in three U.S. communities affected by Hurricane Hugo in 1989. Conditions in the pre-disaster phase allowed for some mitigative actions. Effective pre-disaster mitigation strategies identified in the case communities included active citizen involvement in effective environmental management (for example, organized support for the reduction of shoreline erosion, and conservation of wetlands), which facilitated the conditions to limit the impact of the hurricane. As well, institutional arrangements, including the NFIP, served to limit damages. Adaptive management approaches, encouraging lower density development, local level monitoring to ensure compliance with mitigation regulations and local political leadership to advocate mitigation strategies were evident in the case communities (Reddy, 2000). However, not all possible mitigation measures were adopted, and a lack of leadership for hazard mitigation was identified as a major factor in the limited adoption of mitigation tools. For example, a local council in one of the case communities encouraged the development of lands that would increase the community's vulnerability to future hazard events (Reddy, 2000). The study argued that involvement of private citizens in promoting mitigation is an important component of adoption of mitigation adjustments when local governments were apathetic toward hazard mitigation (Reddy, 2000).

Government disaster relief programs that focus on post-disaster recovery have also been discussed as a barrier to mitigation. Relief programs often reflect the drive to "get the community back to normal" following a disaster event (Tobin, 1999). At the federal level in Canada, the DFAA has historically focused on reimbursing provinces that have provided disaster assistance to return affected public and private property back to their pre-disaster condition (PSC, 2007c). As well, provincial programs, including B.C.'s DFA, provide funding to return affected public and private property and infrastructure back to pre-disaster conditions (British Columbia, 2006). It has commonly been argued that returning affected infrastructure and property to pre-disaster condition serves to sustain pre-disaster vulnerabilities (Barnett, 1999; Mileti, 1999). This phenomenon caused Berke *et al*. (1993) to remark: "Ironically, the prevailing approach of aid and recovery programs has been oriented toward short term relief, with little linkage to long term development…." At the local government level, there is great pressure for government officials to effectively handle a disaster event, and return the community to normal life as soon as possible (Kuban, 1996). Thus, mitigation may be overshadowed by recovery efforts, and pre-disaster vulnerabilities may not be addressed during the post-disaster period.

A substantial body of research has also revealed a low public awareness of disasters, a poor understanding of risk, a lack of support for innovative disaster mitigation techniques, and often, resistance to effective disaster mitigation practices including land use-planning and fuel mitigation in interface areas (Burton *et al*., 1993; McGee *et al*., 2005; Shrubsole, 2000; Slovic, 1999). As the public may be unaware or unwilling to acknowledge disaster risk, political leaders, who serve the public, may have little incentive to initiate disaster mitigation policies (Henstra & McBean, 2005). As discussed in section 2.3.2.1.2, public and political awareness of hazards is often highest during the post-disaster period; however this awareness is generally temporary. As time passes, risk perceptions and support for disaster mitigation tend to revert to pre-disaster levels, thereby reducing support for future disaster mitigation (Arvai *et al*., 2006; Henstra & McBean, 2005). Further, fuel reduction measures that affect the aesthetic value of areas surrounding WUI communities may be viewed unfavourably, as private property owners often live in WUI areas to be within a forested area. Fostering a continued appreciation and awareness of hazard risk for private citizens is a continuing challenge in the effective management of natural hazards.

Significant challenges exist not only in maintaining the hazard awareness of private citizens, but also in fostering action at the private property level to reduce hazard risk. Rather than taking private actions on private property, it has been argued that private property owners are more likely to attribute responsibility for hazard mitigation on local governments, and blame local governments for damages (Arceneaux & Stein, 2006; Morris-Oswald & Sinclair, 2005; Yates, 1998). This may serve as an impediment to the mitigation of hazard risk on private lands. Furthermore, evidence suggests that private individuals prefer hazard mitigation adjustments that alter the hazard itself, and have a lower preference for adjustments that alter exposure to hazards by affecting private property owner behaviour (Kreutzwiser *et al*., 1994; Shurbsole, 2000).

Similarly, private individuals may have an unfavourable perception of wildfire mitigation actions that are aimed at management of fire risk (fuel loads, building practices, and so on) on their own properties. For example, individuals may view building code bylaws that enforce the use of wildfire risk reducing materials and zoning restrictions that affect how they use their property as "unwelcome infringements on their personal freedom" (Winter & Fried, 2000: 41). Homeowners may also view community efforts to encourage mitigation at the individual lot-level as "downloading" of fire management responsibilities to the private property owner (McGee *et al*., 2005). Further, private residents within WUI areas may often view wildland fires as uncontrollable. For example, individuals may lose faith in the effectiveness of their mitigation actions in instances where they have taken steps to protect their homes but still lost their homes during a WUI fire event. Fuel mitigation actins at the community level may also be viewed as having no benefit by the public (Arvai *et al*., 2006; Winter & Fried, 2000).

Uncertainty surrounding local disasters has been identified as an inhibitor to the implementation of mitigation measures. For example, uncertainty about which hazards a community will face, the specific characteristics of the hazards (frequency, magnitude, geographic extent), and uncertainties related to the accurate prediction of hazards can limit the perceived viability of implementing mitigation options (Henstra & McBean, 2005; Klein, 2003). As well, identification and management of community vulnerability is inherently complex (Hebb & Mortsch, 2007) and there may be a lack of understanding of the various factors and components that lead to community hazard vulnerability (Henstra & McBean, 2005). Uncertainty surrounding costs and benefits of disaster mitigation options has also been identified as a barrier to mitigation (McBean & Henstra, 2005). Thus, experience with a disaster may be the most effective means of highlighting the specific vulnerabilities of a community, and a reactive approach to disaster mitigation has become common.

An over-reliance on higher levels of government to implement mitigation and provide mitigation support has also been identified as an inhibitor to disaster mitigation at the local level (Berke *et al*., 1993; Shrubsole, 2000). For example, Shrubsole (2000) argued that local authorities may pass responsibility for minimum flood protection requirements to higher levels of government. Provincial governments are responsible for establishing regulatory flood levels and setting building standards. Individual municipalities are responsible for enforcing said standards through the passage of local bylaws, and in instances where minimum standards are not set by provincial governments, local jurisdictions have considerable discretion in implementing a certain level of flood protection (Shrubsole, 2000). It has been argued that situations such as these may lead to the occurrence of "passing the buck," as municipal government blame higher levels of government for not developing minimum standards (Shrubsole, 2000). In the case of wildland fires in Canada, a significant proportion of wildfire management funds are allocated to suppression at the landscape level. Communities often do not have strategies to manage fuel risk in WUI areas, and may leave proactive wildland fire risk mitigation to higher levels of government (Arvai *et al*., 2006).

Jurisdictional issues have also been identified as a barrier to pre-disaster wildfire mitigation in communities in Canada. McGee *et al*. (2005) reported that communities have faced jurisdictional barriers to implementation of building code bylaws that restrict the use of fire-vulnerable materials, as jurisdiction for building codes is allocated to the provincial government. Jurisdiction is also an issue in the management of fuel loads in areas adjacent to municipalities. Fuel loads in Crown lands adjacent to municipalities can be a significant factor in increasing WUI fire risk (McGee *et al*., 2005). In the event that provinces do not take action to manage these loads, local authorities may have limited abilities to ensure that fuel loads are managed. For example, municipalities cannot pass bylaws requiring property owners to manage fuel loads in Crown lands adjacent to their properties, even though such action may benefit the entire community.

Various other factors can affect the ability of a community to implement mitigative measures, and thus may lead to increased vulnerability to hazard events. Further factors include (Tobin, 1999):

- Population growth and urbanization;
- Socioeconomic characteristics of the population (including social/economic inequities, aging populations, education levels, literacy);
- In-migration (e.g., new residents with a lower awareness of the hazards of the area, and therefore, a higher vulnerability);
- Environmental degradation (e.g., forest health issues);
- Encroachment into hazard prone lands (as a result of rising populations), and;
- Cultural factors (e.g., the marginalization of the homeless and poor).

The barriers to effective disaster mitigation are strong enough that Tobin (1999) referred to sustainability and resilience of communities, specifically with regard to natural disasters as "the holy grail" of planning for natural hazards.

2.4.3.1. Liability as a barrier

Very little has been written discussing the link between emergency management and legal liability of governments in Canada (Henstra and McBean, 2004). Some researchers have argued that liability for potential disasters may be an enabling factor in municipal mitigation decisions. For example, Henstra and McBean (2005) argued that, as there is the risk of liability for poor emergency planning (including adequate pre-disaster mitigation), governments would be more willing to take action to reduce the potential of disaster damages. Local authorities must be careful to ensure that disaster mitigation policies are designed in a way that does not expose them to liability, for example, mitigation policies that are overly restrictive, or are based on incomplete or inadequate data (Kusler *et al*., 1985).

Roman (2002) discussed the potential for municipal liability for post-disaster situations. The author argued that as municipalities are responsible for taking emergency prevention or preparedness actions, it is "virtually certain" that a municipality will face liability following disaster situations (Roman, 2002: 2).

The municipality may be sued by individual business owners or residents for damages, or by companies that provide insurance to property owners within the municipality. Indeed, litigation has been brought against several municipalities for damages associated with infrastructure maintenance and emergency call responses (Campbell *et al*., 2007). Roman (2002) described two broad areas in which a municipality could potentially be held liable in negligence:

- Inadequate preparedness to prevent or limit a preventable emergency, and;
- Inadequate preparedness in response to an emergency, causing more severe harm.

Roman (2002) goes on to describe some steps that municipalities can take to mitigate the risk of liability, including identifying and addressing risks that may lead to disaster situations (i.e., pre-disaster mitigation). Roman (2002) further argues that the risk of liability following disaster events is increasing, due to, among other factors, the increasing occurrence of class action lawsuits.

A specific example of the potential impact of liability on a community's ability to mitigate fire threats are liability issues associated with the donation of used equipment from private organizations to volunteer fire departments. In the community of Bastrop, Texas, a special program has been developed to ensure that the donation of used equipment does not lead to liability issues for the donor (Hudson, 2004). It has also been argued that the use of prescribed burning, one of the more effective means of controlling fire risk, may expose authorities to liability, as the risk of an escaped prescribed fire can never be completely eliminated (Yoder, 2004).

Internationally, liability associated with natural hazards has been an issue as well. For example, local governments in Sweden can be held accountable for flood damage if that government has provided permission to develop in that area. During flooding in 2000, no buildings with permits that were provided after 1990 were damaged (Chrichton, 2008). In this case, the risk of liability proved to be an effective enabler in this situation for local government to ensure that development is not sited in a manner that would expose it to flood risk.

Liability can be viewed as a significant risk for local governments. However, the threat of liability can serve as an enabler for disaster mitigation, through creating a significant incentive for a local municipality to appropriately mitigate a hazard in the pre-disaster time period.

2.5 Insurance

Insurance can play a critical role in the recovery of communities following a disaster event. Insurance can serve to provide needed funds to individuals who have suffered damages from disasters, and therefore increase the ability of communities to quickly recover from disaster impacts. Insurance played a significant role in the B.C. wildfires of 2003, as the wildfires resulted in 3,385 claims totalling approximately $200 million (IBC, 2008).

Despite its important role in recovery, this mechanism has been criticised for maintaining vulnerability in hazard prone communities. For example, insurance generally provides funds to return damaged structures back to pre-disaster condition and provides no additional assistance for mitigative measures. In some instances, insurance has been criticised for exacerbating vulnerability to natural hazards as it may cause individuals to be careless or apathetic toward an insured peril. For example, an individual who believes they have full insurance for a peril would be less likely to adopt mitigative adjustments than one who believes they would hold complete financial responsibility for damages (McLemen & Smit, 2006).

Despite these shortcomings, insurance is considered to have more potential to promote disaster mitigation than government disaster relief, as insurance requires the regular payment of premiums for coverage, where disaster relief is essentially a free government service. Premiums and deductibles can be adjusted to reflect the risk of individual homeowners and therefore provide an incentive for homeowners to reduce their risk (Burby, 2001; Mills, 2007). Economic incentives can be a far more effective means of changing individual behaviour when compared to other programs aimed at changing behaviour (such as education programs) (Burby, 1998). Further, he insurance industry has a substantial history in affecting building codes and other regulations to reduce losses. Examples include the insurance industry's role in increasing auto safety and reducing structural fire risk (Mills, 2007).

The high penetration of insurance coverage has also been discussed as an opportunity for applying this tool to incentivize disaster mitigation. Homeowner insurance penetration in Canada is very high as it is a common requirement for securing a mortgage and is of relatively low cost for most homeowners. Coverage for fire damage is a basic component of every homeowner insurance policy and is included along with other common perils including theft and vandalism (IBC, 2006). Therefore, insurance methods designed to increase mitigative behaviour can reach a substantial portion of homeowners, including those in high-risk areas.

Though uptake of homeowner's insurance is likely extremely high in Canada, there may exist issues with insurance coverage for many Canadian homeowners, renters and small business owners. Potential issues include underinsurance and a low rate of adoption of renter's insurance. Further, many small businesses owners may not purchase business continuity insurance.

Underinsurance has been identified as an issue in recent wildfires in the United States. Danko (2005) stated that approximately 340 underinsurance complaints were filed out of 3000 insurance claims following a severe wildfire event in October, 2003. Factors that caused underinsurance included actions by the insurer, such as charging a rate that was not adequate to cover risk and errors in the valuation of the property, and actions of homeowners including failure to report renovations and upgrades to their insurance provider (Danko, 2005).

The Insurance Information Institute estimated that 64% of American homes are underinsured by an average of 27% (III, 2004). Data on underinsurance in Canada is limited; however Canadian insurance professionals have suggested that the underinsurance situation in Canadian might be similar to that in the U.S. (Charbonneau, 2006; Harder, 2008). Underinsurance in Canada can result from underestimating the value of structures, misunderstanding insurance policies, failures of insurer and insured to communicate regularly, and a poor understanding of the value of home contents (Danko, 2005; Harder, 2008). Further, evidence suggests that many Canadian homeowners do not have a good understanding of their insurance policies. A survey conducted by the Insurance Bureau of Canada in 2007 revealed that Canadians have a poor understanding of what is and is not covered by home and auto insurance (Pollara, 2007). Although home based-businesses require either an extension or additional policy for adequate coverage, the survey revealed the belief that damages caused to a home-based business were covered by a typical home insurance policy (Pollara, 2007). As well, a 2003 study in the province of Nova Scotia found that only 66% of small and medium sized business owners purchase business interruption insurance (Hachey, 2003).

Renters and small businesses may not be adequately covered for all insurable perils in Canada. A 2006 survey by the U.S. Insurance Research Council found that only 43 percent of all renters were insured, despite the relatively low cost of renters insurance. Though there is no data on penetration of renter's insurance in Canada, discussions with insurance industry professionals suggest that the majority of renters in Canada do not purchase renters insurance.

Underinsured individuals would likely be paying a premium rate that does not reflect their risk, and may not receive full coverage for their damages. They would also be ineligible for assistance through government disaster relief programs, as fire is an insurable risk. Thus, a situation of underinsurance may serve to limit the ability of individuals to recover from disaster impacts. A misperception of hazards and hazard mitigation tools, including insurance, has been well established in the disaster mitigation literature (Burton *et al*., 1993; Mileti, 1999). Findings from recent studies (IBC, 2007) support the findings of many previous studies, and the fact that individuals have a poor understanding of mitigation and hazard management tools should come as no surprise to policy makers.

Figures from the Insurance Bureau of Canada suggest large multiple-payment events caused by natural hazards is a significant concern for the Canadian insurance industry, and evidence from multinational reinsurance companies suggest that disaster damages have been rising exponentially over the past few decades (IBC, 2008, Munich Re, 2006). Insurance can serve as an important tool to assist in disaster mitigation, thus the insurance industry should have a vested interest in managing disaster risk.

3. Methods

3.1. Data gathering

Information on the experience of the City of Kelowna before, during and after the OMPF was gathered through discussions and interviews with City of Kelowna staff. A meeting was held on November 20, 2007 with seven high-level City of Kelowna staff. A summary of this meeting is available in Appendix A. As well, in April 2008, follow up interviews were conducted with six high-level city staff. Interviews were conducted using a semi-structured format, and a face-to-face interview method allowed for immediate explanation and refining of questions. Participants are listed in Appendix B. Interviewees were assured confidentiality, and that their names and positions would not be directly associated with comments made in the interview. The interview schedule is available in Appendix C. Ongoing communications with various city staff also allowed access to various internal city documents and consultant reports.

3.2. Case study

The City of Kelowna is located on Okanagan Lake in south-central British Columbia. Kelowna is adjacent to the Okanagan Mountain Provincial Park, a back-country wilderness park of 11,038 ha (B.C. Parks, 2008). The Okanagan Mountain Park, along with Crown lands surrounding the City of Kelowna and green space/treed areas within the City of Kelowna result in an interface fire risk (Blackwell & Needoba, 2006; City of Kelowna, 2004). As well, forest health issues (including the Mountain Pine Beetle epidemic), suppression policies, and several other factors have lead to a situation of increased fire risk in forest ecosystems both within and surrounding the City (Arvai et al., 2006; City of Kelowna, 2004b).

With an estimated 2007 population of 116,479, Kelowna is the largest municipality located within the Central Okanagan Regional District (B.C. Stats, 2008). The Cty of Kelowna is rapidly growing in comparison to the province of British Columbia, with a total population change between 2001 and 2006 of 10.8% (Statistics Canada, 2008a). As well, when compared to its neighbouring Okanagan Lake municipalities, the City of Kelowna has the largest population and the second largest population increase from 2001 to 2006 (Tables 10 & 11). Statistics Canada estimates that in 2006, 13.5% of Kelowna residents over the age of 15 had attained a university certificate, diploma or degree (compared to 19.3% for the province of British Columbia) (Statistics Canada, 2008a). The median household income in 2006 was $48,859 (compared to $52,709 for the Province of British Columbia) (Statistics Canada, 2008a).

Table 10: Comparison of population changes in Kelowna and B.C.

Year	Population of Kelowna	Percent of change	Population of B.C.	Percent of change
2003	104,350	–	4,155,370	–
2004	105,182	0.8%	4,203,807	1.2%
2005	108,559	3.2%	4,260,246	1.3%
2006	111,802	3.0%	4,320,255	1.4%
2007	116,479	4.2%	4,380,256	1.4%

Source: B.C. Stats, 2008

Table 11: Comparison of population and population change amongst local municipalities

Municipality	2006 population	Percent of population change from 2001 to 2006
Kelowna	111,802	10.8%
Vernon	35,944	7.2%
Penticton	31,909	3.0%
Westbank	28,972	11.4%
Summerland	10,828	1.0%
Lake Country	9,606	3.7%
Peachland	4,883	4.9%

Source: B.C. Stats, 2008; Statistics Canada, 2008a-g.

3.2.1. 2003 Fires in British Columbia and the Kelowna area

The 2003 fire season in British Columbia was the largest, most intense, damaging and expensive on record. The abnormally hot and dry conditions lead to 2473 individual forest fires, of which fifteen were WUI fires (Hystad & Keller, 2006; Ministry of Forests and Range, 2008). A total of 334 homes were destroyed, and 45,000 people were evacuated in the province during the fire season (Filmon, 2004). The total cost of the season was $700 million (2003 dollars) in property losses and forest fire fighting efforts (Filmon, 2004). As well, three pilots died while fighting fires in the province (Filmon, 2004).

As shown in Table 12, the B.C. Ministry of Forests and Range states that the average number of forest fires in the province of B.C. over the past ten years was roughly 1800 (Ministry of Forests and Range, 2008). However, the average fire was significantly larger in 2003 than normal, and there was a much larger area burned, and a considerable number were WUI fires (Filmon, 2004). Thus, the 2003 fires had a far greater impact on human populations than had previously been experienced.

Interface fires occurred in many communities. The largest of these interface fires occurred in Chilko Lake and Alexis Creek (the Chilko Fire), McLure and Barriere (the McLure fire) and in the area south of Kelowna (the Okanagan Mountain Park Fire) (Filmon, 2004). Of all the interface fires that year, the Okanagan Mountain Park Fire resulted in the most significant damages.

Similar to other years, a portion of the fires were caused by humans and the remainder were the result of lightning strikes. Thirty-nine percent of these fires of 2003 were human-caused, and 61% were caused by lightning (Ministry of Forests and Range, 2008).

Table 12: Number, area burned and average size of fires in B.C.

Year	Number of fires	Hectares burned	Average hectares burned per fire
2007	1604	29,404	18.3
2006	2570	139,265	54.2
2005	976	34,588	35.4
2004	2394	220,518	92.1
2003	2473	265,053	107.2
2002	1783	8,539	4.8
2001	1266	9,677	7.6
2000	1539	17,673	11.5
1999	1208	11,581	9.6
1998	2665	76,574	28.7
1997	1175	2,960	2.5
Average:	1804.9	78,643	35.4

* Source: B.C. Ministry of Forests and Range, 2008

3.2.1.1. The Okanagan Mountain Park Fire

The Okanagan Mountain Park Fire (OMPF), ignited by a lightning strike on August 16, 2003, grew to be the third largest and most damaging interface fire in 2003 (Filmon, 2004). The fire destroyed hundreds of homes in Kelowna and resulted in evacuations in the communities of Kelowna and Naramata, British Columbia (Beck & Simpson, 2007).

The OMPF burned for over a month, and fire fighting continued through the end of August and into September (Hystad & Keller, 2006). A total of 238 homes were destroyed, including a small number of lodges and bed-and-breakfast operations. Many other homes suffered smoke and water damages (Hystad & Keller, 2006). At the highest point of evacuations, 26,000 residents were evacuated, 15,000 others remained on 1 hour evacuation notice (Hystad & Keller, 2006). Fire fighting was challenged, as resources had to be shared amongst several other severe wildfires occurring in the local area. As well, winds and dry conditions exacerbated the OMPF creating difficulties for fire crews (Ministry of Forests, 2003). A timeline of events is presented in Table 13.

The OMPF had significant impacts on many facets of the community. Public and private infrastructure, approximately 1/3 of the residents of Kelowna and many businesses suffered direct impacts from the OMPF. Substantial staff diversions were required within the Corporation of the City of Kelowna, and many departments became involved in the response, recovery and mitigation of fire impacts. Similar to other years, a portion of the fires were caused by humans and the remainder were the result of lightning strikes. Thirty-nine percent of these fires of 2003 were human-caused, and 61% were caused by lightning (Ministry of Forests and Range, 2008).

Table 13: Timeline of events for OMPF

Date	Significant event
August 16	Lightning strike ignited a fire 15 km SE of the City of Kelowna in the Okanagan Mountain Park at 1:55 am. First 911 call received at 1:58 am. Emergency Operations Centre activated at 8:00 pm. First evacuation alerts issued for southern most residences of Kelowna.
August 17	Fire reached 4 km to closest homes, and 6 km from the City of Kelowna.
August 18	Aggressive fire fighting continued. Further evacuation orders and alerts were issued.
August 19	Fire affected two communications towers. Unified Command Structure created, fire set to enter the City of Kelowna. Further evacuation alerts and orders issued.
August 20	Fire reached 11,000 ha in size, and consumed 95% of the Okanagan Mountain Park. Restrictive travel advisory declared province wide, prohibiting entrance into back-country areas. City of Kelowna informed provincial fire authorities of intention to construct a large fire guard to help protect the City.
August 21	Unified Command set up between fire and emergency authorities and the City of Kelowna as the fire approached the City. Fire reaches 13,000 ha in size.
August 22	OMPF approached City limits, exacerbated by high winds, and pushes through Kelowna neighbourhoods. 3000 residents evacuated at this point. 21 structures lost overnight. Wildfire and structural fire fighters worked to save structures threatened by the fire. "Structural triage" considered to limit overall losses.
August 24	Prime Minister tours affected areas. Evacuated residents informed of which homes were destroyed.
August 25	Agricultural day-passes issued.
August 26	Tour for residents of Crawford Estates who lost their homes.
August 28	Ramping down of EOC, further tours for residents who lost their homes. Information forum held for affected residents. Many evacuation orders were rescinded, new evacuation orders for areas at risk as the fire moved north towards the June Springs Road. area.
August 30	Evacuation order lifted for Naramata.
September 3	EOC activated to handle emergency as fire moves toward another part of the city (June Springs Rd. area). Two trestles in the Kettle Valley Railway national historic site are destroyed by the OMPF.
September 4	Fire reaches 22,840 ha.
September 5	Six more Kettle Valley Railway trestles destroyed.
September 15	Province-wide state of emergency lifted.
September 16	OMPF contained.

Sources: Beck & Simpson, 2007; City of Kelowna, n.d.a; Hystad & Keller, 2006; 2008; Filmon, 2004; Ministry of Forests, 2003

Hystad and Keller (2006; 2008) provided some analysis of the impact of the OMPF on the local tourism industry. The City of Kelowna has a considerable tourism industry, which focuses on the City's lake and mountain environment, agriculture and wine, and recreational activities afforded by local parks and trails (Hystad & Keller, 2006; 2008). As well, the Kettle Valley Railway national historic site attracted tourists from around the world (Hystad & Keller, 2008). The tourist sector was particularly affected, as the OMPF occurred during the peak of the tourist season in Kelowna. Further, the OMPF had a significant impact on many of Kelowna's local tourist attractions. Specifically, the Okanagan Mountain Park was severely affected by the fire. The fire also destroyed the Kettle Valley Railway national historic site, requiring $15 million for repair of the trestles, a key attraction of the site (Hystad & Keller, 2008). Results of the studies revealed that the tourism industry was generally poorly prepared for a disaster and small businesses and accommodation businesses were most vulnerable to the disaster (Hystad & Keller, 2008; 2006). The authors also reported that some businesses effectively adapted to the disaster and a few may have even benefited from the disaster. It was also found that Tourism Kelowna's approach to strategies to combat

negative media coverage of the impact of the OMPF on the tourism sector was effective. The authors report that tourism was greatly affected during the peak season (during and after the OMPF), but was recovering three months after the disaster. Long term impacts included heightened tourism risk perceptions associated with fire seasons, which lead to last-minute bookings. As well, the authors revealed that many businesses were still unprepared for disaster impacts several years after the OMPF (Hystad & Keller, 2008).

There was also evidence that the OMPF resulted in health impacts, as visits to physicians for respiratory diseases were observed during and shortly after the OMPF (Moore *et al*., 2006). As well, 100 residents of a private care facility in Kelowna had to be evacuated during the OMPF, requiring significant assistance from health professionals (Berry *et al*., 2008).

Although the size and impact of the OMPF was unprecedented, the City of Kelowna had experienced wildland fire events in the past. For example, the Garnet Fire of 1994 resulted in the mobilization of emergency services and the implementation of mitigation measures including identification of fire hazard areas in the City. The Knox Mountain fire, which burned in the Knox Mountain area directly north of the City, came during one of the most severe fire seasons up to that point in B.C. (B.C. Protection Branch, n.d.). While the fire did not destroy significant amounts of infrastructure and homes, it resulted in the mobilization of emergency management resources and the implementation of various mitigation measures. For instance, the Knox fire was a factor in the development and implementation of fuel mitigation measures in the City.

There was some evidence that fire suppression in the Okanagan Mountain Park may have lead to an increased fire risk, and may have been a contributing factor in the intensity and severity of the OMPF (Filmon, 2004). Reports following the OMPF suggested that the Okanagan Mountain Park missed three disturbance intervals (three instances where fires would have burned through the park during natural cycles, which would have served to mitigate fuel-loads in the park), and fuel-loads may have contributed to the intensity of the OMPF (Arvai *et al*., 2006; Filmon, 2004).

Arvai *et al*. (2006) conducted wildfire management perception surveys of private individuals affected by the OMPF and provincial Protection Branch fire management staff. Part of the study was designed to understand how individuals perceived the causes of the OMPF. Respondents were provided with a list of possible factors that played a role in the severity of the wildfire. Half of the factors presented are factors that were under the control of humans, for example, forest management practices and a suppression-focused fire management philosophy. The other half included factors out of the control of humans, including climate change, drought conditions and natural forest aging (which also contributes to fuel build-up) (Arvai *et al*., 2006). The results revealed that public and provincial respondents believed that natural factors had a greater impact on the fire occurrences than the human controlled factors.

3.2.1.1.1. Post wildfire hazards

In addition to the immediate fire hazard, wildland fires have the potential to have a substantial impact on forest ecosystems. Wildfires can strip forests of vegetative cover, and can therefore increase the risk of erosion and debris flow (land and mudslides) during intense rainfall events (Shakesby & Doerr, 2006; Underwood & Schultz, 2003; Woods *et al*., 2007). Intense fire events can also impact soil, and cause soil hydrophobicity, which results in reduced absorption of water and higher overland flow rates during heavy rainfall events (Woods *et al*., 2007). These hydrophobic soil conditions, combined with loss of vegetative cover, can lead to increased peak flows during heavy rainfall events, and therefore increase risks associated with flooding. Further post-wildfire hazards may include (Castanet, 2003):

- "Widow Makers" (also referred to as "danger trees," which are trees damaged by the fire, and have limited structural support. They also lack limbs, which causes their fall to be silent);
- "Easy Bake Ovens" (below ground burning root structures, which cause extremely hot and unstable soil conditions; can pose a hazard to those traveling on recently burned terrain);
- Falling limbs from damaged trees;
- Hazards associated with failing power infrastructure (e.g., destabilized hydro poles);
- Structural hazards from burned homes, buildings and other damaged infrastructure, and;
- Other post-wildfire hazards associated with back-country use of areas affected by wildland fires.

These post-fire risks present a hazard to communities and threaten human life, private property and public infrastructure.

3.2.1.1.2. The B.A. Blackwell & Associates report

In October 2006, an extensive policy review report was completed for the City of Kelowna by B.A. Blackwell & Associates (Blackwell & Needoba, 2006). The purpose of the report was to identify challenges associated with the mitigation of wildfire risk in WUI areas within the City of Kelowna and to "make recommendations for changes of policies, procedures and bylaws that will effectively reduce the City's wildfire risk" (Blackwell & Needoba, 2006: 7).

The report argued that effective fuel management in public land is a necessary, although partial, component of wildfire risk reduction. In order to control damages in the WUI, mitigative adjustments must be employed at the private property level, specifically the management of fuel loads on private forested lands, fuel management around private buildings and enhanced structural characteristics to manage fire risk. Further, the report supported (Blackwell & Needoba, 2006):

- An integrated approach to wildfire risk management, which includes appropriate fire suppression along with modifications to human settlements (fuels management in private forested lands, appropriate changes to structures to reduce ignitability);

- Accurate and up-to-date risk assessments (e.g. mapping of WUI areas and fire prone areas, regularly updated risk maps, local level control over risk mapping);
- Fire management strategies at the local level;
- Understanding/incorporating local specific values of those who occupy WUI areas into policies;
- Coordination of actions and efforts of all stakeholders, including federal, provincial, municipal governments, and local/private land owners to reduce wildfire risk, and;
- Coordinating various bylaw and policy responses across different departments.

The authors discuss two types of safety/wildfire risk mitigative options that are commonly adopted by local governments. Type one includes "regulations that restrict the use of fire" and type two regulations include "regulations that restrict building materials, require setbacks or restrict zoning" (Blackwell & Needoba, 2006: 12). The authors suggest that local government may choose from a variety of type two mitigative adjustments, including:

- Voluntary fire risk reduction for landowners (building materials and landscaping);
- Bylaws for building materials and subdivision design;
- Covenants requiring setbacks and vegetation spacing;
- Site assessments that determine the imposition of fire protection taxes;
- Education;
- Zoning in fire prone areas, and;
- Treatments on private and public land (including commercial thinning, non-commercial thinning, mechanical thinning, clear-cut commercial harvesting or prescribed burning).

The authors argue that type one regulations are more favorable by private homeowners, as type two regulations impede the choices private individuals make about the placement and aesthetic qualities of their homes. Further, they argue that the success of the implementation of type two mitigative adjustments will depend largely on the values and risk perceptions of individual property owners (Blackwell & Needoba, 2006).

The report acknowledges the potential difficulties in encouraging private individuals to manage fuel on their own land. For example, private property owners may be unwilling to expend resources (time, money) on managing fuel loads on their own properties. As well, amenity values are placed on vegetation within private property. The report argues that availability of full insurance for fire damage may also reduce uptake of type two mitigative adjustments. To offset public resistance, the authors argue that government incentives and financial aids may encourage private action (Blackwell & Needoba, 2006). Further, the authors argue that the public should be educated on the environmental and ecological benefits of certain types of fuel management strategies, particularly prescribed fire, to increase public support for these actions at the community level. The authors argue that a better understanding of the environmental benefits of fuel management may increase action at the private property level as well (Blackwell & Needoba, 2006).

The report argues that many mitigation strategies, including factors associated with structures and building materials and set-backs would be more difficult to implement in existing subdivisions. The report goes on to state that subdivision design is an important aspect of WUI fire damage mitigation. The authors state that the "major aspects of subdivision design that influence wildfire risk are access, water pressure and hydrant locations" (Blackwell and Needoba, 2006: 17). To support effective evacuation during a wildfire event, the width of streets and cul-de-sacs should be determined. As well, water pressure can be affected by the size of water mains, and spacing of fire hydrants affect fire-fighter access to hydrants (Blackwell & Needoba, 2006).

As there continued to be a high fire risk in Kelowna, the authors argued that there was a need for a high standard of wildfire mitigation. The report discussed actions that had already been implemented in the City of Kelowna, including better emergency response coordination with the Ministry of Forests and Range, and the use of wildfire risk assessments for the development of Wildland Fire Hazard Development Permit areas (Wildfire DP) which require wildfire mitigation considerations in new development. Despite the progressive strategies already implemented before the review, the authors argued for the need for continued work on wildfire mitigation.

3.2.1.1.2.1. Residential survey

A residential survey was completed as part of the Blackwell & Needoba (2006) review. The residential survey sampled individuals from select communities within the City, and investigated:

- Wildfire risk perceptions;
- Adoption of individual/lot-level mitigative adjustments (e.g., "FireSmart" recommendations);
- Perceptions of responsibility for wildfire mitigation;
- Perceptions and awareness of government actions to reduce wildfire risk;
- Support for enforcement of mitigative adjustments through bylaws, and support for adjustments that may result in increased taxes, and;
- Issues surrounding values associated with combustible material (fuel) and fuel removal.

The survey revealed varying levels of risk perception in different areas of the City. The survey revealed that the majority of individuals who lived in areas that were affected by the 2003 OMPF were less likely to perceive risk, as they believed that the loss of vegetation as a result of the OMPF would reduce the risk of future wildfires (Blackwell & Needoba, 2006). As well, respondents accepted responsibility for wildfire mitigation along with the provincial and municipal governments, felt that the City of Kelowna had done enough to protect respondents' homes from wildfires, and supported bylaws that quired private homeowners to take wildfire mitigation actions. The survey also revealed that adoption of FireSmart roofing materials varied across areas in the City, and adoption of 10 metre fuel-free zones was extremely limited.

3.2.1.1.2.2. Wildfire risk

Blackwell & Needoba (2006) discussed factors that affected wildland fire risk in Kelowna, including factors at the landscape, subdivision and individual lot level, as well as in city green spaces. At the landscape level, the report identified a lack of fuel management on Crown lands as a wildfire risk concern. At the subdivision level, the report identified the following concerns:

- Fire vulnerable roofing materials within wildfire development permit areas, in both older and current subdivision construction;
- Proximity of homes to fire-prone vegetation, located on city owned green spaces and privately owned undeveloped lots;
- Deficiencies in the City's current covenant process, which is designed to reduce wildfire risk in new subdivisions;
- Emergency vehicle access to WUI areas, and;
- Water pressure and hydrant locations in some areas of the City.

At the individual/lot level, concerns included:

- Many private land owners maintain landscaping that is vulnerable to fire, despite active communications programs;
- New homes in some subdivisions did not meet FireSmart standards;
- Inadequate setbacks around many homes;
- The use of building materials in new homes that do not meet FireSmart standards, and;
- Lack of removal of hazard trees on private property.

Finally, in areas that are classified as city parks and green spaces:

- Considerable build up of fuel in some areas;
- The city may at times receive or purchase subdivision land that has not undergone proper fuel mitigation;
- Insufficient access to parks and green spaces, inconsistent planning for access points to parks and green spaces, and;
- Forest health issues that exacerbate fire risk.

As described above, Blackwell and Needoba (2006) suggest that fire risk still remained in Kelowna at the time of the report.

3.2.1.1.2.3. Recommendations and adoption of recommendations

The Blackwell and Needoba (2006) review produced 26 wildfire management recommendations for the City of Kelowna (Appendix D). The recommendations include rational for implementation, responsibility for implementation of recommendations, and cost/resources requirements for implementation. As well, priorities were assigned to he various recommendations using the categories of "High," or "Medium". A total of 18 recommendations were considered "High" priorities, 8 were considered "Medium" (Blackwell & Needoba, 2006).

Documentation from the City of Kelowna indicated 14 of the recommendations were identified as priority actions for the year 2007, summarized in Table 14 (Parkes, 2006). The majority of the actions slated for adoption were mitigation related, including fuel management, fire resistant building practices, encouraging mitigation of fuel on Crown Land, developing mitigation standards, encouraging interagency participation in fire mitigation actions, fire breaks, and improving public education. Response related actions included increasing accessibility of developments and isolated areas, and hydrant placement.

Table 14: Priority actions for 2007

		Action type	
		Response	**Mitigation**
Level of action	**landscape risk level assessment**		• Work with B.C. Building Policy Branch to foster fire resistant building design • Lobby province to increase fuel management on Crown land
	Parks and green spaces	• Improve access to isolated areas for access and fire control • Integrate access points in new subdivision design for evacuations and fire response • Consider placement of hydrants with respect to forested parks	• Incorporate fire resistant roofing material in new and existing development • Place roads between subdivisions and forested lands to improve access and act as fire break • Adopt standardized Registered Professional Forrester Reports to ensure consistency of mitigation practices in development permit areas
	Public and private property owners		• Inventory sensitive ecosystems to reduce adverse impact of fuel treatments • Adopt a standard for fuel management in green spaces • Manage fuel in trail networks (limit spread and improve and improve suppression abilities) • Consult with Parks department during subdivision development to review mitigation plans, allow Parks site inspection of mitigation on lands before delivered to city, Parks review of mitigation work on individual properties • Require developers to mitigate fire hazard on forested lands before they become property of the City • Enhance public education, incorporate wildfire safety into primary school curriculum, create sticker program to identify properties that are FireSmart

Sources: Blackwell & Needoba, 2006; Parkes, 2006

3.2.1.1.3. Mitigation strategies

Through discussions with City of Kelowna staff and review of city and consultant reports, several mitigation strategies were identified that were designed to increase the City of Kelowna's resilience to future wildfire and post-wildfire hazards. These strategies included:

- An analysis of the impacts of the wildfire on watersheds surrounding the municipality, and actions taken to regenerate biota to mitigate post-wildfire flood risks, as well as infrastructure improvements to address increased flood risks following wildfires;
- Creation of "development permit" areas to address fuel loads in newly developed lands within WUI fire risk areas. The development permit areas were defined based on a reassessment of previous fire risk maps;
- Wildfire abatement covenants, which address wildfire risk in newly developed lands and set out responsibilities for management of wildfire risk by property owners;
- An extensive policy and procedure review (the Blackwell & Needoba, 2006 report), including a public consultation process, which produced 25 recommendations, 14 of which were adopted as action items for the year of 2007;
- Dissemination of FireSmart wildfire risk reduction information to private property owners within the City's jurisdiction, success of which has been seen in the increased amount of material being collected during the city's semi-annual yard waste pickups;
- Implementation of fuel management strategies since 1998, and the development of a fuel management strategy to address future wildfire risk in the WUI (developed in 2004), and;
- Significant expenditures on mechanical fuel management within the City of Kelowna (over $1 million in 2007).

The city independently developed effective communications strategies (response) and a recovery resource management strategy (recovery) as well. Though these strategies cannot be considered mitigation, they provide evidence of an autonomous and adaptable municipal government, thus displaying characteristics of a resilient system.

4. Results and discussion

This section explores the resilience of Kelowna to the 2003 OMPF. The experience of Kelowna is discussed in the context of resilience to natural hazards. The experience of the City of Kelowna was shaped by many factors, including the provincial and federal approaches to disaster management, and the specific circumstances of the City of Kelowna.

The following topics are explored below, as they relate to the City of Kelowna:

- Impacts of the OMPF on various departments in the City;
- Wildfire risk mitigation and private property owners;
- Altering physical development patterns to reduce vulnerability;
- Development permit areas;
- Learning from other communities;
- Assessing fire-prone areas;
- Communications strategies;
- Fire guard;
- Evacuation;
- Insurance, government relief and recovery resource management;
- Recovery centres;
- Post-wildfire hazard mitigation;
- Post-wildfire flood mitigation, and;
- Post-disaster policy window and municipal staff awareness.

Interviewee perceptions of risk and the resilience of Kelowna are also provided, for wildfire hazards and other natural hazards. Interviewees were asked to comment on their perceptions of the following topics:

- Time taken for the City of Kelowna to fully recover from the OMPF;
- Ability of the city to reduce the impacts of the OMPF;
- The perception of the recurrence of future severe wildland fire events;
- Impacts of the experience with the OMPF on the management of future disasters (non-wildfire);
- The role of higher levels of government in the management of wildland fire and post-fire hazards;
- The role of private property owners in fire risk mitigation, and;
- Lessons learned in the area of emergency management.

Finally, barriers to the implementation of effective wildfire and post-wildfire mitigation strategies are discussed for the case study of the City of Kelowna. Barriers, identified by City of Kelowna staff, reduced the ability of the City to implement pre- and post-wildfire mitigation strategies, and originated from governmental institutional arrangements, the changing nature of the wildland-urban interface, and the perceptions and values of the public and private property owners.

4.1. OMPF impacts on the Corporation of the City of Kelowna

The OMPF had a significant impact on the City, and interviews with city staff revealed that many departments experienced both direct and secondary impacts. Specific city departments greatly affected by the OMPF and identified by city staff included:

- Works and Utilities;
- Planning and Development Services;
- Kelowna Fire Department ;
- Recreation, Parks and Cultural Services, and;
- Financial Services.

Interviews and discussions with City of Kelowna staff indicated that the Works and Utilities department was greatly impacted by the OMPF. Services that were particularly affected included:

- Stormwater management (drainage);
- Water infrastructure;
- Road infrastructure;
- Environmental services, and;
- Solid waste management.

A post-fire analysis of lands affected by the OMPF revealed an increased flood risk due to hydrophobic soil conditions. Thus, drainage practices in affected areas had to be altered to address an increased flood risk. Drainage improvements required significant resources from the Works and Utilities departments. During the fire, the Works and Utilities department was instrumental in maintaining water pressure to assist in fire-fighting. In one section of the City, the OMPF resulted in a power failure in one pumping station and water had to be brought in by truck to compensate. However, power was maintained at the majority of pumping stations, and water supply did not create a significant issue. Damaged infrastructure, including road infrastructure, resulted in an increased burden on the Works and Utilities department as resources were diverted for repair during the post-fire period. The environment division played an essential role in the identification of post-wildfire hazards and in the rehabilitation of areas affected by the OMPF. As well, city staff indicated that solid waste was a significant issue resulting from the OMPF. Management of solid waste was reported as a significant problem, specifically, dealing with solid waste created by damaged homes. Management of this waste resulted in significant costs and created concerns over the lifespan of landfills used by the City of Kelowna due to the amount of waste. Handling solid waste created by fuel management was also identified as an issue.

The department of Planning and Development Services was impacted by the fire for several reasons. Interviews revealed that planning staff were extremely valuable in the emergency management process, as these staff possessed an intimate knowledge of the local developments and communities. For example, planning department staff assisted emergency officials in the identification of new and roughed-in roads to assist

in evacuation efforts. As well, planning staff were instrumental in identifying buildings that were affected by the OMPF, through identifying what type of building existed before the fire, and through identifying burned homes so homeowners could be identified. Interviewees also reported that insurance companies stopped issuing policies for new home construction for some time during the post-fire period, thus new home construction stopped for a period of time following the fire. Reconstruction after the fire also increased the work load on this department.

The Fire Department was significantly involved in the management of the OMPF emergency. Staff reported that the fire services were able to handle the increased work load created by the OMPF, and the Fire Department was able to handle routine emergency calls (e.g., traffic accidents) during the OMPF. However, the OMPF did create post-incident stress issues, and employees were required to work longer hours than normal. As well, some staff lost homes during the OMPF, and interviewees reported that it took several years for some staff to have their homes rebuilt.

The department of Recreation, Parks and Cultural Services was also affected, particularly through its urban forestry section. Urban forestry was particularly affected, as areas of the City impacted by the OMPF required rehabilitation. The OMPF resulted in some long-term impacts on the urban forest. As well, urban forests were a significant concern in the development of fuel management strategies (City of Kelowna, 2004b). Additionally, the Finance Department experienced impacts from the OMPF. For example, a significant subrogation case was brought against the City, which required the involvement of Risk Management services.

Staff indicated that, in fact, all departments were somewhat affected as resources and staff were diverted to handle the emergency situation. Interviewees indicated that municipal employees who were viewed as good decision makers and leaders were asked to assist during the emergency situation, regardless of their official responsibilities. These individuals were often senior staff within their departments. As well, the lack of city level social services was identified as an issue in the post-disaster period. City staff indicated that individuals had to be pulled from other departments to fill this gap, and many of these staff were not adequately trained to deal with social services issues. As well, staff from various departments were directly affected by the OMPF, including the loss of homes from the OMPF. Interviewees indicated that the overall impact on the corporation of the City of Kelowna lasted between 2 and 4 years following the fire.

4.2. Wildfire risk mitigation and private-property owners

As explored in many hazard management studies, private individuals have an extremely crucial role in the management of WUI wildfire hazard risk. The city of Kelowna has taken significant actions to engage the public in wildfire risk mitigating behaviour, including the use of the FireSmart program guidelines. Municipal staff indicated that programs designed to increase public engagement in wildfire mitigation had increased following the OMPF, as had public interest in mitigation. However, municipal staff indicated that interest was still not high, and that interest has decreased after the OMPF. All staff interviewees indicated that the public had an extremely important role in mitigating wildfire hazard risk in Kelowna.

A review of private property owner actions, as discussed by City of Kelowna staff, reveals a continuum of actions by the public. Generally, in the pre-disaster period, private wildland fire mitigation actions, in the form of vegetation management, were cited as low. In the period immediately preceding the OMPF and after the fire, mitigative actions increased. As indicated by municipal staff, increases in fire mitigation actions were at least partly a result of municipal communications actions.

In the period preceding the OMPF, municipal staff generally agreed that private property owners had not taken necessary actions to reduce fire risk on their own properties, and were generally unsupportive of fuel management initiatives, including prescribed burning and tree removal. Municipal staff indicated that in some cases, Kelowna residents were resistant against attempts to manage fuel loads in the Okanagan Mountain Park. Staff indicated that this resistance was a result of the public perception that the Okanagan Mountain Park was a natural area, and should not be subject to human intervention for the purposes of fuel management, including prescribed burns.

Interviews with staff revealed that communications in the pre-disaster period increased private-property action for mitigating fire risk. For example, city staff were sent to high fire-risk areas and requested that private property owners clean their yards and property of fire-prone debris. The notice to clean up fire prone yards was made during the fire event, and it was believed by city staff that these actions significantly reduced fire risk in fire-prone areas.

Staff further cited increases in mitigation actions following the fire. An interviewee indicated that there was a 10 to 12 fold increase in the amount of solid waste collected by the City during this time period. Staff cited increased yard debris pickups following campaigns focused on reducing wildfire risk as evidence of wildfire risk mitigating behaviour by private property owners in the City of Kelowna. City staff indicated that the City has been particularly progressive in the promotion of open-air burning, as a cost effective method of controlling fuel loads and handling solid waste burdens. For example, the City has adapted the local ventilation index to allow for increased burning when necessary.

Interviewees reported that FireSmart practices had been communicated and encouraged well before the occurrence of the OMPF. For example, private residents were informed of risks associated with wildfire and actions that can be taken to mitigate wildfire risk starting in approximately 1995. However, interviewees indicated that the communications may not have been as aggressive as necessary. It was also acknowledged that individuals may not have paid attention to FireSmart program messages until after the OMPF, as the severe fire event served to solidify many of the messages provided through the FireSmart program.

Staff reported that other actions, aside from vegetation management, were actively adopted after the OMPF. Private individuals were more actively adopting recommendations made through the FireSmart program, for example the adoption of lower-risk roofing materials. As well, municipal staff indicated that the City had been more aggressive in educating the public on FireSmart recommendations, and other factors in wildfire risk, for example, the potential impacts of beetle kill on fire risk in

WUI areas. Further, the City provided increased capacity for solid waste pickup during the fire to encourage private wildfire mitigation. Wildfire hazard and risk areas were also identified, and included in city documents including the Official Community Plan (City of Kelowna, 2006).

Despite increased adoption of wildfire mitigation actions, municipal staff indicated that many of those who lived in high-fire risk areas had still not adopted low-risk roofing materials. As well, although municipal staff indicated that they had been working to implement effective public education programs, the municipality lacked the authority to enforce certain actions, for example, the bylaws requiring private homeowners to install FireSmart approved roofing materials.

Wildfire covenants have been in place to deal with new developments and sub-divisions. These covenants pertain to new developments, and require that wildfire risk reduction measures be taken for these developments (discussed below). However, encouraging existing property owners to adopt wildfire risk reduction measures has proven more difficult for City staff. Specifically, the City has had difficulties due to a lack of authority for the enforcement of these mitigative measures.

A more comprehensive FireSmart education program was undertaken in 2006. Measures taken to promote the adoption of risk reduction adjustments by the public and developers included:

- Open houses to educate the public on wildfire risk reducing actions;
- Education programs to promote the FireSmart manual;
- Development covenants to ensure that new development incorporates risk-reducing adjustments, and;
- Mapping and communicating wildfire prone WUI areas.

Municipal staff also believed that the insurance industry could be a valuable partner in the incentivizing of fire mitigation actions by private residents. Interviewees felt that, as the insurance industry is at risk of paying for the majority of damages during a WUI fire event, it should be interested in fostering mitigation.

4.3. Alteration of physical development to reduce vulnerability

As discussed above, vulnerability to wildland fires in urban areas is largely created through development within or adjacent to wildland areas. The City of Kelowna is a rapidly expanding area, and has experienced significant population increases over the past few years (Statistics Canada, 2008a-g). As well, a significant portion of the City of Kelowna jurisdiction has been identified as hazard-vulnerable areas (City of Kelowna, 2006). Municipal staff indicated that there is significant pressure to develop in all areas of the City, including those that have been identified as hazard-vulnerable areas. Development patterns, specifically, those which have located vulnerable property in WUI areas, were identified as a major issue in the occurrence of damages during the OMPF in Kelowna.

Assessment of wildfire-prone areas within the City and ensuring that mitigative methods are incorporated into development within these areas were cited as the most effective post-OMPF wildfire mitigation efforts by some municipal staff interviewees. Altering physical development to reduce WUI fire vulnerability was considered a priority following the OMPF, and the City enacted building covenants in WUI areas that required new developments to include wildfire mitigation adjustments. According to staff interviews, the OMPF illustrated the connection of sub-division design in the wildland-urban interface and wildfire risk for the planning department. Various characteristics of development areas, including spacing and type of vegetation surrounding structures, and building materials used in the structures were identified as contributing factors to WUI risk and damage. Thus, development covenants were created to ensure that new developments incorporate FireSmart principles. Indeed, one interviewee commented that "right now, when people pull out development proposal applications in hazard-vulnerability areas, they are handed FireSmart manuals." Developers must ensure that certain wildfire mitigation measures are met before lands are transferred to the City. Lands that must adhere to wildfire mitigation standards include areas that are to be used as parks in newly developed lands. For example, the City's development covenant states that the following actions, among others,
that should be taken by developers:

- Maintain appropriate space between trees in developed lands and existing treed areas;
- Prune branches within three metres of the ground to control ladder-fuels, and other actions to ensure ladder-fuels do not grow;
- Use fire resistive materials on roofs and exterior of structures;
- Ensure house address is visible, so it can be seen by the fire department;
- Development area must include a pre-planned escape route;
- Reduce fuel on the ground;
- Maintain and irrigate lawns, and;
- Provide garden hose and sprinklers that can be used to reduce fire risk.

Development covenants designed to reduce vulnerability to wildland fires are aimed at reducing the occurrence of WUI areas. The covenants apply to development permit areas, as described in the City of Kelowna's official community plan (City of Kelowna, 2006). Interviewees indicated that effective implementation and enforcement of these restrictions would significantly reduce vulnerability to WUI fires in Kelowna.

4.4. Learning from other communities

Learning from the experience of other communities in the management of disasters is an important characteristic of a resilient community. The City of Kelowna, through its emergency management process, applied lessons learned both from direct involvement in the management of wildfires in other communities and through researching other communities that experienced similar wildfire disasters.

As discussed earlier, the summer of 2003 was a particularly severe season for wildfires in British Columbia, and many fires affected many communities. Shortly before the start of the OMPF, the McLure fire affected several communities north of Kamloops, British Columbia (Filmon, 2004). Louis Creek and Barriere were among the affected communities.

Several staff from the City of Kelowna, including staff from the Kelowna Fire Department, assisted other communities in the handling of WUI fires, shortly before Kelowna experienced the OMPF. Staff directly involved in the McLure Fire indicated that their experience in Barriere served as an important learning opportunity. Staff indicated that poor notification for evacuation, poor communications, and inadequate identification of other safety hazards were a significant concern during their experience in Barriere. Staff indicated that this experience served as a partial driver in the development of Kelowna's effective communications plan.

Staff indicated that the severity of the fire season in 2003 may have taken several communities off guard, and thus many communications and response actions may not have been adequate. The city of Kelowna had the advantage of experiencing a severe wildfire event after many other communities had sustained impacts. Thus, there was a knowledge base on which to draw regarding the current abilities of government agencies and individuals for handling severe wildfire events.

As well, jurisdictions in the southern Untied States were examined for their actions related to post-wildfire risks, and infrastructure improvements to control hazards. The experiences from Canberra, Australia were also reviewed and applied to many aspects of WUI fire management in Kelowna.

4.5. Assessing WUI Fire Hazard Areas

Identification of WUI fire hazard areas is considered an important aspect of the City of Kelowna's wildland fire management approach. A progression in the methods used to assess wildfire-hazard prone areas within the City of Kelowna was experienced before and after a local fire in 1994, and after the OMPF. Interviewees reported a relatively unscientific approach to the identification of WUI fire hazard prone areas. Following the OMPF, WUI fire hazard areas were more stringently identified.

In 1994, the Garnet fire burned through the Okanagan Region, east of Penticton (Ko, 1995). Following this event, the City of Kelowna, through the environment, planning and fire departments, began assessing wildland-urban interface fire risk areas. Interviews with city staff revealed that methods for assessing wildfire areas during this time were "unscientific," and relied purely on the judgments of the local fire chief and long-range municipal planner.

More scientific modeling undertaken following the OMPF, which considered several of the parameters that were taken into account following the 1994 fire, including dead-end streets and slope characteristics. As well, the City of Kelowna parks department has been taking a more progressive evaluation of the impacts of steep

slopes and other risk factors on public lands in the time following the OMPF, and staff indicated that various city departments are more progressively monitoring and enforcing wildfire mitigation actions, which were reported as more "lax" before the occurrence of the OMPF.

4.6. Communications

Discussions and interviews with City of Kelowna staff revealed strong satisfaction with the methods in which they communicated with the media and with affected individuals during and following the OMPF. The City of Kelowna's media communications strategies during and following the fire, including frequent press conferences, were cited as a factor that increased community satisfaction with wildfire fighting actions taken by the municipal government. The Filmon review (2004) specifically identified the City of Kelowna as having an effective media communications strategy, where many other municipalities who suffered the impacts of wildfires during the 2003 wildfire season were relatively ineffective at providing information to the media and the public in general (Filmon, 2004).

The successful approach of the City of Kelowna appeared to be an exception during the 2003 fire season. Transcripts of testimonials for the Filmon review from CBC reporters revealed issues surrounding communications in the province during the 2003 wildfire emergency. Among other difficulties, a lack of information provided to the press, issues surrounding government agency confrontation with reporters, and restricting press from fire areas were identified in the transcripts. As well, the reporters cited a poor system surrounding the provision of evacuation notices from the provincial government. Specifically, the reporters stated:

> …the government had a very poor system for issuing evacuation alerts and orders. It appeared to me that they were relying on personnel who had little local knowledge of the area…and…these were at times quite dense communications, they were difficult to read through on the air" (Filmon Review, 2003, public meetings in Kelowna: 71).

However, the testimony did state that the experience was different, depending on community.

The testimonial cites a successful communications strategy in the City of Kelowna. The transcript states that the Kelowna situation "was a text book example of how to handle communications during an emergency situation" (Filmon Review, 2003, public meetings in Kelowna: 72).

Some of the elements identified as part of the communications strategy included:

- Frequent press conferences (held between 9am and 10am each day of the emergency);
- Good spokespeople, and;
- Allowing reporters access to fire impacted areas.

Interviews with municipal staff revealed that the City took a positive attitude toward the media, viewing the media as an important tool to inform Kelowna residents. As well, the city staff adopted the responsibility of adapting technical evacuation orders to suit the local knowledge of the city residents. The Filmon transcript states that

> "local people with local knowledge of the city were in charge of putting together the evacuation orders; there were few mistakes and oversights. Now we heard earlier that these had to be cleared through the Fire Commissioner however the local people went though the maps and they did a very good job of identifying the streets that were affected" (Filmon Review, 2003, public meetings in Kelowna: 72).

As well, the transcript states that the Ministry of Forests allowed media into fire areas in Kelowna (Filmon Review, 2003, public meetings in Kelowna: 72). Staff interviews indicated that this was done to accommodate the media, and reduce confrontations with reporters, and was useful in keeping Kelowna residents informed about the state of heir homes.

Staff reported that there was some criticism of the openness of their communications strategy, particularly surrounding allowing media staff access to wildfire areas. A case was cited where media were allowed to enter an area where the wildfire returned later the same day. However, staff reported that it was important that the City didn't "become the story," as was arguably the case in other communities affected by the 2003 fire season. Thus, Kelowna staff made efforts to ensure that media had access to information and affected areas to ensure that the focus of the story was on fire impacts, rather than municipal responses to the fire. Generally, staff indicated that they would not change the communications strategy in future disaster situations.

During the fire, the media were asked not to disclose whose homes had been destroyed by the OMPF. In late August, the City of Kelowna held a town meeting for those whose homes were destroyed during the OMPF. City staff reported that the meeting was very well received, and in fact, a standing ovation was provided to the City following the communication that homes had been destroyed. City staff viewed this occurrence as public satisfaction with the City's handling of the fire, particularly the thorough communications strategy.

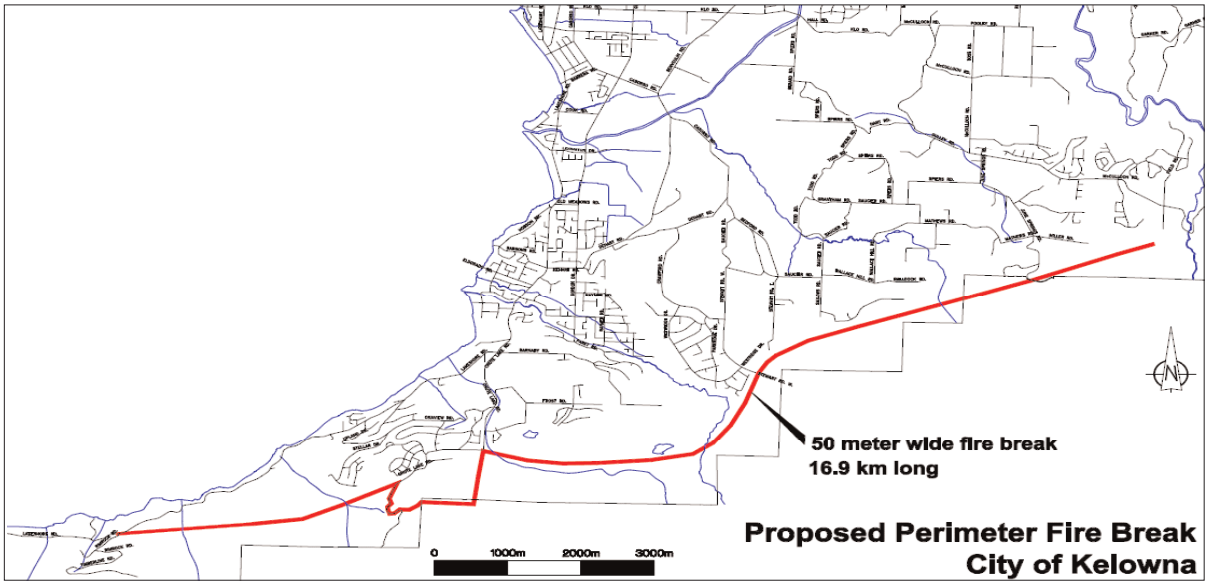
The "Okanagan Mountain Fire Watch" (Castanet, 2003), a website provided under the "Castanet.net" website (a local Kelowna information website) was cited by City staff as a valuable tool used to provide information to the public on the fire situation. The website provided information on many topics relevant to the public, including media reports of the fire, donation information, maps of fire progress, pictures of the fire and other relevant topics. As well, emergency phone numbers and agencies, road closures and other emergency information was also listed on the site.

As discussed above, several staff from the City of Kelowna assisted in disaster response and recovery efforts in the McLure fire, and had first-hand experience with impacts of the communications strategy, and other responses to the fire event. The experiences of staff in these other communities increased the awareness in the municipal government of the impacts of a poor communications program, thus focusing efforts at ensuring a good communications strategy.

4.7. Fire guard

Another component of resilience is the ability to adapt to new situations, and apply expertise to solve problems. A response and disaster mitigation action cited by municipal staff as relatively novel was the decision to develop a large fire-guard around the City to mitigate the impacts of the OMPF, by preventing the fire from entering some parts of the City (Figure 3).

Figure 3: Fire guard



Source: City of Kelowna, accessed from Castanet, 2003

A fireguard (or firebreak) is essentially a narrow field (or strip) where vegetation has been cleared, and is located between the forested area and the community. The removal of vegetation or fuel in a fireguard area reduces the ability of the wildland fire to enter the community.

The fire guard passed through sections of private property (Dobson Engineering Ltd, 2003), and, as reported by city staff, partially took the route of future roadways. When the fireguard was being constructed, city staff indicated that there was no presumption of funding assistance from higher levels of government, nor were private property owners compensated for damages to their property. As well, there was no assistance from higher levels of government for remediation of areas affected by construction of the fire guard after the fire risk had passed. Although city staff indicated that this was an unconventional method of managing a WUI fire emergency situation, it was credited with saving several neighbourhoods from the oncoming fire.

4.8. Disaster Recovery Centres

The Disaster Recovery Centres were cited as one of the more successful approaches to assisting individuals affected by the OMPF. The disaster recovery centres were designed to assist individual residents in acquiring emergency provisions, and in planning their recovery strategies (applying for loans, etc.), and were described as a "one stop shop" for individuals seeking assistance for damages suffered during the OMPF. As well, partnerships were developed with non-profit agencies to develop a "needs assessment"

to facilitate the provision of emergency supplies to residents (discussed further below). Recovery centres were open for one year following the fire, and were staffed by full time and part time City employees. One provincial staff member was also involved in the disaster recovery centres. A wide range of services were available to individuals seeking assistance, including the opportunity to apply for recovery assistance and a list of recovery resources and agencies that could assist those affected by the fire. The recovery centres changed supplies and resources as residents` needs changed throughout the recovery period. For example, shortly after the fire, resources such as clothes were available, and as the recovery process continued, new resources such as assistance with securing loans and permits to rebuild homes were provided.

Municipal staff indicated that in many instances, communities affected by a large disaster do not have the resources to provide adequate assistance to affected individuals during the recovery phase. However, the City of Kelowna chose to implement recovery assistance programs, including recovery centres, to aid those who suffered the impacts of the OMPF.

4.9. Insurance and recovery resource management

A fast recovery from a disaster event is a characteristic of a resilient community. Insurance certainly plays a role in hazard recovery, as it allows for the rebuilding of damaged buildings and infrastructure in the post disaster period. As fire is an insurable peril, the provincial disaster relief program did not play a substantial role in assisting fire victims with recovery. Much of the non-insurance funds that were provided to disaster victims came through charitable donations, managed through the Kelowna and Area Okanagan Fire Recovery Society.

4.9.1. Insurance coverage

Kelowna staff interviewees revealed the perception that insurance companies, by and large, performed well assisting in disaster recovery and were considerable aids in the recovery process for impacted individuals. Generally, the fire impacted an area of the City that was considered relatively well-off, and it was perceived that these individuals had adequate insurance and were compensated for their damages.

However, there were reports of some issues with under-insurance and cases of individuals being uninsured for fire damages (interviewees indicated that there existed four uninsured residences). Under-insurance was reported as a significant concern for many of those affected by the fire. For example, municipal staff indicated that some homeowners had not kept their insurance policies up-to-date following home renovations, and therefore did not receive full-replacement value for destroyed homes. It was also reported that some homeowners may have felt that they were treated unfairly by their insurance companies, in instances where homes where underinsured.

Although the majority of those affected were able to purchase insurance, municipal staff reported some instances of tenants and renters living in secondary suites within homes in the affected areas that were not covered by insurance for their damages. Staff indicated that some of the renters were living in illegal suites, which had not been approved by the City. This situation complicated recovery processes, particularly whether or how recovery resources should be provided to occupiers of illegal suites.

4.9.2. Recovery resource management

Several actions were taken to manage and coordinate donations and the services of charitable organizations in the time following the OMPF. These actions included the formation of an organization to oversee disbursement of recovery relief donations, a process for identifying donations for individuals affected by the fire and ineligible for other sources of funds, and an information sharing strategy to ensure that recovery funds were provided in an efficient and equitable manner.

The Kelowna and Area Okanagan Fire Recovery Society (the Society) was formed in September 2003 to collect and administer recovery and relief donations provided for the OMPF. The Society was formed to ensure that there would be no political interference with the distribution of donated funds, and to ensure that funds were donated only where necessary.

The following priorities were used by the Society for the provision of donated funds (Society, 2004):

- Urgent unmet needs: To provide individuals without insurance for items such as housing and housing contents, and other related urgent needs;
- Individual claims: For individuals who had insurance for their losses, but experienced shortfalls in their insurance coverage;
- Community groups: For community organizations that could provide assistance and projects for the recovery effort, and;
- A Commemorative Project: To provide a small amount of funds to assist in the construction of a project that would commemorate the impacts of the OMPF.

The society also collected funds for restoration of the Kettle Valley Railway national historic site. Though the Society had expected to handle anywhere from $700,000 to $800,000 in donations, the final amount received by the Society was $1,402,000.

An Urgent Unmet Needs committee was set up, at the request of the City of Kelowna, early in the donation distribution process. Many individual organizations were in place during the recovery from the OMPF, and integration of these organizations was viewed as an essential part of an equitable and efficient recovery process. The Unmet Urgent Needs committee had representatives from many aid organizations, including:

- Red Cross;
- Salvation Army;
- Royal Canadian Legion;
- Lions Clubs;
- Adventist Disaster Response;
- Central Okanagan Foundation;
- Interfaith Groups;
- CORD/City of Kelowna Victim Services;
- City of Kelowna, and;
- The Society.

As well as providing assistance for urgent needs, a Cooperative Housing Strategy was also developed by the Committee to ensure that uninsured residents who lost their home were compensated with suitable accommodation (Society, 2004).

To ensure that people affected by the OMPF were adequately assisted by the various aid organizations, information sharing agreements were drafted, which allowed for transfer of information between the City of Kelowna and the various aid agencies. The agreements allowed for aid agencies and the City of Kelowna to share information about specific families and individuals, and what they were qualified to receive, to ensure that each eligible individual received some recovery funding. As an example, an agreement drafted between the City of Kelowna and the Salvation Army, British Columbia Division, Kelowna Corps, stated:

> The purpose of providing the Contact List to the Salvation [Army] is to ensure that direct financial assistance is made available to those persons who have been directly affected by the Fire and to ensure that this aid is delivered in a fair and equitable manner (City of Kelowna, n.d.b).

The agreements ensured that information sharing was in accordance with the Freedom of Information and Protection of Privacy Act, and that appropriate actions were taken to ensure confidentiality of contact information.

Individual claims were assessed on a "needs basis", that is, payouts were provided to those with the greatest needs. The needs assessment was created by a partnership between the City of Kelowna and the Red Cross. Individuals applying for aid were asked at the Disaster Recovery Centres. The Society assessed applications and payouts based on the level of need for the following damages (Society, 2004):

- Loss or damage to homes and household contents;
- Loss or damage to outbuildings;
- Loss or damage to property used for home-based businesses where the business was the primary source of family income;
- Loss or damage to landscaping;
- Cost of tree removal, and;
- Loss or damage to infrastructure.

Various other charitable organizations were also involved in assisting affected individuals, including the Salvation Army and the Mennonite Disaster Relief fund (Berry *et al*., 2008).

4.10. Post-wildfire hazard mitigation

In 2004, the City of Kelowna, through its Environment Division, initiated the Central Okanagan Post Fire Habitat Rehabilitation Project. A contract was awarded to Interior Reforestation Co. Ltd. to assess post-wildfire hazards, and to provide tools and recommendations for the rehabilitation of forests affected by the 2003 wildfire.

Among the various findings of the engineering team, an increase in the occurrence and intensity of overland flows caused by hydrophobic soils was identified as one of the more substantial threats to Kelowna residents and infrastructure. The Kelowna City Council approved a $2 million plan to improve culverts to address the risk of heavy water flows in the event of heavy rainfall and freshet flooding (Forrex, n.d.; FPB, 2005).

As discussed in Section 3.2.1.1.1., other post-wildfire hazards existed, aside from flood hazards. Information on these hazards was provide through the City's ongoing communication strategy (discussed in Section 4.6.).

Wildland fire can have a substantial impact on the soil and vegetative characteristics of affected areas. Increased risk of mass-erosion and landslide is common in sloped areas that have been affected by wildland fires (Shakesby & Doerr, 2006). Landslide hazards are a constant risk in Kelowna due to the community's adjacent interior mountain terrain. Kelowna's Official Community Plan includes sections regarding hazardous condition development permit areas, including areas with a slope greater than 30%. Kelowna staff reported a considerable increase in landslide hazards post-OMPF. Following the OMPF, assessments of landslide risk had to be conducted before contractors and homeowners were allowed to return to areas affected by the fire. At the time of writing, the City has been in the process of revising its landslide risk maps through soil and soil stability analyses.

4.10.1. Post-wildfire flood mitigation

Hydrophobic soil conditions, caused by heat from extreme wildfire events, are common after severe wildfire events (Onda *et al*., 2008). Hydrophobic soil conditions can increase the risk and severity of overland flows, caused by heavy rainfall events and can increase the risk of erosion (Certini, 2005; Woods *et al*., 2007). Many communities that have experienced severe wildland fire events have experienced hazards associated with hydrophobic soils, including the risk of flooding and soil erosion (Onda *et al*., 2007; Woods *et al*., 2007).

Following the severe fire season of 2003 in British Columbia, The Post-Wildfire Hazard Assessment and Risk Management report (FPB, 2005) explored the roles and responsibilities of different provincial and local authorities in the management of post-wildfire hazards. The report identified the following key players in post-wildfire risks:

- B.C. Ministry of Forests and Range (MOFR);
- B.C. Provincial Emergency Program (PEP);
- B.C. Ministry of Environment (MOE);
- B.C. Ministry of Transport (MOT);
- Local authorities, including regional districts and municipalities, and;
- Utilities and railways.

The roles and responsibilities of each of these organizations and authorities vary. For example, MOFR is responsible for suppression of wildfires, PEP coordinates emergency response activities and strategies, MOE may be involved in mapping debris-flow areas or in responding to mass wasting events, MOT assesses extra-municipal development proposals, local authorities are responsible for development within their boundaries, and utilities and railways can assess and mitigate risks to their own infrastructure. However, none has a specific mandate to reduce the risks of post-wildfire hazards through preventative planning and forest regeneration.

Despite the lack of clarity in the roles and responsibilities for mitigation of post-wildfire hazards, the City of Kelowna adopted a progressive approach, and initiated programs to mitigate post-wildfire hazards. In 2004, the City contracted a consultant to review post-wildfire hazards and provide approaches to rehabilitate lands affected by the OMPF (Wright & Przeczek, 2005). Among the various findings of the review, an increase in the occurrence and intensity of overland flows caused by hydrophobic soils was identified as one of the more substantial threats to Kelowna residents and infrastructure (Wright & Przeczek, 2005).

4.10.1.1. Post-wildland fire flood risk management in Kelowna

Several approaches were taken to manage post-wildfire flood hazards in Kelowna at various government levels. For example hydroseeding, performed by the provincial government, was identified as a factor in reduced post-wildfire flood and erosion risks. However, the City played the most significant role in the management of this hazard.

Following the OMPF, the City undertook a post-fire hazard analysis, including the commission of Dobson Engineering Ltd. to assess the impacts of the fire on surrounding slopes and stream catchments and provide recommendations for post-fire hazard mitigation. Results of the Dobson study identified various impacts of the fire, including erosion, stability hazards, hydrophobic soils, increased sediment loads in streams and other impacts on surface water, as well as environmental issues including habitat loss (City of Kelowna, 2004a; Kam, 2005). Hazards that posed the greatest risk to Kelowna residents included:

- Increased erosion and sedimentation of streams;
- Changes in the magnitude and frequency of runoff and peak flows, and;
- Flash floods and debris laden floods (City of Kelowna, 2004a).

Hydrophobic soil conditions were considered to increase the risk of both flooding and land slides following the OMPF. As well, ash and sediment loads increased flooding and erosion hazards. Watersheds affected by the OMPF were located both within the City of Kelowna and on Crown land (City of Kelowna, 2004a). The hydrophobic soil conditions were present on large portions of watersheds, which originate on Crown land and flow through the City of Kelowna to Lake Okanagan (City of Kelowna, 2004a).

Typically, the City of Kelowna maps flood risk areas based on 1 in 200 year events, and requires that stream crossings accommodate 1 in 200 year flows, under natural conditions. However, the hydrophobic conditions following the OMPF significantly increased the severity of 200 year events. A severe rainfall event in October 2003 on several of the burnt-out watersheds supported findings from the risk analysis, as peak flows during the storm were estimated to be between 5 and 15 times the 200-year pre-fire flows (City of Kelowna, 2004a).). Overland flows caused by the severe rainfall event resulted in $120,000 in damages to infrastructure, and caused damage to private lands and homes. Using the impacts of this storm, it was estimated that 50 homes, 150 residents, and 10 roadways were at risk from flash flooding (City of Kelowna 2004a). As well, property and infrastructure at risk was estimated at $10 million, based on watershed modelling and the 2003 flood event (City of Kelowna, 2004a). It was expected that hydrophobic soil conditions would last 3 to 5 years following the OMPF, and total regeneration of the forest canopy could take up to 30 years.

4.10.1.1.1. Mitigation works and appeal for funding

In 2004, the City of Kelowna developed and presented a funding proposal for mitigation works to prevent damages associated with increased risk of flooding caused by wildfire impacts (post-wildfire hazard). The proposal was directed at the federal government, as the hazard originated from wildfires that took place on Crown land (City of Kelowna, 2004a).

The proposal adopted a risk management approach, including an assessment of the risks associated with fire-impacted soils, and an assessment of a variety of options for mitigating post-wildfire hazard risks. The proposal identified 15 options that could be employed to reduce the increased risk of flooding caused by hydrophobic soils, which included (City of Kelowna, 2004a):

1. Altering the Landscape:
    a. Grass seeding of exposed soils to restore vegetative cover;
    b. Harrowing soil to break up water repellant layer, and;
    c. Contour furrows to reduce erosion and runoff.
2. Altering Channels:
    a. Dyking to increase channel capacity and reduce flooding;
    b. Detainment structures to store flash runoff;
    c. Overflow structures to pass flood flows safely;
    d. By-pass structures to provide alternate routing for flood flows, and;
    e. Larger structures designed to safely pass flood flows.
3. Hardening Structures:
    a. Raise structures at risk above flood levels, and;
    b. Construct berms around structures at risk to protect from flooding.

4. Remove Consequence:
   a. Purchase properties at risk and remove structures, and;
   b. Change land use to prevent consequences.
5. Early Warning Systems:
   a. Install climate stations with rainstorm alarms;
   b. Install water level gauges with level alarms, and;
   c. Install flood-warning alarms on road crossings.

The flood mitigation options were evaluated based on criteria concerned with reducing the risk to public safety and reduce the risk of loss of life, protection of private property from flood damages, protecting public infrastructure from flood damages and consideration of the most effective approach to attain the criteria (City of Kelowna, 2004a). The various options were also evaluated based on general "pros and cons," their impact on risk reduction and cost (City of Kelowna, 2004a). A review of all available options based on these criteria identified "larger structures designed to safely pass flood flows" as the preferred option. These larger structures would come in the form of culverts at locations where streams from the affected watersheds cross road infrastructure (for examples, see Figures 4 and 5). In all, 40 crossings were analyzed, and 35 of those crossings were identified as requiring alterations to structures. As well, alterations to stream channels and construction of detainment works were undertaken. The goal of the City of Kelowna was to implement the flood risk reduction measures before the occurrence of the 2004 spring freshet flooding.

Figure 4: Larger crossing at Chute Lake Road and Frost Road, Kelowna

Figure 5: Larger crossing at Lebanon Creek and Lakeshore Road, Kelowna

In 2004, the City of Kelowna estimated a total cost of $1.75 million for channel improvements required to reduce the risk of flooding caused by hydrophobic soils, however, interviewees indicated an actual cost of $2 million. The proposal made to the federal government for funding mitigative works was that the $1.75 million investment would save $10 million in property damage, as well as save governments potential disaster relief assistance payments that would be made following a severe flooding event, exacerbated by hydrophobic soils (City of Kelowna, 2004a). Interviewees indicated, however, that no funding assistance was provided by the provincial or federal governments for these works.

Municipal staff interviewed suggested that the federal and provincial governments were unwilling to provide funding for post-wildfire flood risk reducing actions as these actions were related to mitigation rather than recovery. In a briefing note developed by the City of Kelowna, municipal staff expressed frustration over the lack of higher level government assistance with significant proactive mitigation works implemented to reduce post-wildfire hazard risks.

The proposal to the federal government goes on to cite specific incidents in the United States where post-wildfire flooding and debris flows were identified as serious hazards. In these incidences, the proposal highlights funding provided to local areas to mitigate these risks, through programs such as the Hazard Mitigation Grant Program (City of Kelowna, 2004a).

As described by the proposal, and exemplified by the October 2003 heavy rainfall event, the mitigation works substantially reduced risks to residents located close to watersheds affected by the fire. As discussed in Section 2.4., the PEP and PSC administer disaster relief programs aimed at providing private individuals, small business and municipal governments with assistance for recovery after a disaster has occurred. These programs largely exclude actions that are designed to enhance infrastructure, and rather, are designed to assist disaster affected communities with repairing infrastructure up to a pre-disaster state. Thus, disaster mitigation was not a primary aim of these programs.

4.11. Post-disaster policy window

Interviewees indicated past events in the City of Kelowna served as drivers for enhanced WUI fire mitigation strategies. Municipal staff reported previous events, including the 1994 Garnet Fire and the Knox Mountain fire of 1998, which served to highlight potential vulnerabilities to city staff, and lead to improved fire management practices in the past. For example, historic wildfires, including a fire at Knox Mountain in 1998, were factors in the development of fuel modification initiatives in Kelowna. As well, the Garnet Fire of 1994 lead to a limited WUI fire risk identification initiative. Interviewees indicated that municipal government staff and officials became most aware of vulnerabilities to fire risk during and after the onset of the OMPF. Municipal staff acknowledged a post-disaster window of opportunity, in which public and political interest in implementing wildfire mitigation measures was high. Interviewees estimated that this window of opportunity existed for two years.

Municipal staff awareness was cited as an important component of disaster preparedness and an increased ability to mitigate future disasters by Kelowna city staff. An important factor in increased resilience to future fire events was the increased awareness of fire-prone areas, and managing development in these areas. Public and political awareness were also reported as important factors in the uptake of various mitigative adjustments both at the individual and community levels, for example, adoption of FireSmart practices on individual lots and the implementation of mitigation responsibilities for developers.

Several departments had undertaken education actions well before the occurrence of the OMPF, as early as the mid 1990s. However, staff interviewees indicate that it was not taken very seriously by Kelowna residents until the time following the OMPF. As discussed in Section 4.2., public interest in the management of fuel loads on their property increased significantly immediately before and during the OMPF.

Fuel mitigation work on public lands within the City of Kelowna began in 1998. Since the occurrence of the OMPF, a more comprehensive fuel management strategy was developed for the City of Kelowna (City of Kelowna, 2004b). As well, a more progressive strategy to identify WUI fire risk areas has been adopted. Staff interviewees further discussed the impact of the OMPF on City Council's willingness to adopt and implement post-fire flood abatement adjustments. An interviewee commented that council was very willing to adopt and implement flood management strategies, because the recommendations came to them while the "embers were still burning" from the OMPF. Staff indicated that the council was highly aware of the vulnerabilities of the City to natural hazards and therefore was very willing to adopt adjustments.

Despite the apparent window of opportunity and the range of programs adopted following the OMPF, interviewees believed that many of the programs that were implemented following the OMPF would have been implemented regardless of an extreme fire event. However, staff indicated that implementation of these programs may not have been as aggressive had the OMPF not occurred. The experience of Kelowna suggests that this may be true, as many of the wildfire mitigation programs

implemented following the OMPF were enhancements of existing programs, including the identification of WUI wildfire risk areas. However, extensive policy reviews, such as the Blackwell & Needoba report (2006), likely would not have been conducted had there not been a significant loss event.

Staff interviews were conducted approximately five years after the occurrence of the OMPF, and several interviewees indicated that there has been a drop in political and public interest for the implementation of wildfire mitigation measures. As well, staff feared that over the long term, public and political interest in fuel management practices generally (e.g., fuel management on public lands) and private property owner fuel management and FireSmart behaviour would wane, thus leading to an increased risk of fire. . Further, the two year window of opportunity was severely affected by ongoing litigation brought against the City by the insurance industry for damaged incurred during the OMPF (described further in Section 4.13.1.).

4.12. General perceptions of OMPF

This section provides results from other sections of the interview questionnaire, which explored general perceptions of the OMPF, the ability of the City to handle future fires, and the impact of the OMPF on the ability of the City to handle other types of disasters.

4.12.1. Time taken to recover from OMPF

As discussed in Section 2.3., the amount of time taken to recover from a disaster is an important component of the definition of a resilient community. Interviews with municipal staff revealed the perception that the overall time taken for the City of Kelowna to fully recover from the impacts of the OMPF was two years. Interviewees were also asked to estimate the time taken for those who lost their homes to rebuild. Estimated times varied (between 6 months and 3 years), however, staff generally agreed that all homes were rebuilt two years after the fire. As well, approximately 2 years was required for the rehabilitation of affected infrastructure.

Municipal staff indicated that it was likely that some property owners directly affected by the OMPF had likely not recovered. For example, there were a few cases of homeowners with no insurance, or with inadequate coverage, who may still be suffering financial impacts associated with the loss of their home. As well, municipal staff indicated that there were several property owners who chose not to rebuild in the same area where they were affected by the OMPF, out of fear of a future fire occurrence. Interviewees also indicated that many of those who were affected may still be suffering from emotional impacts caused by the extensive loss of property and personal items.

Interviewees indicated that there were some instances of individuals who were considered as culturally or socially isolated seeking assistance from the City during and after the OMPF. These people were defined by municipal staff as "persons-with-no-fixed-address," who had made homes in forested areas outside of the City of Kelowna, and did not enter the City or seek city services on a regular basis. Staff indicated that the recovery resource management process was useful in providing assistance to these people.

4.12.2. Risk perceptions associated with recurrence of fire events

A key component of a resilient community is the ability to adapt to hazards, and through such adaptation, be able to handle or reduce impacts of natural hazards through the application of lessons learned. These lessons may be derived from a community`s own experience, or the experience of other communities. The following section describes risk perceptions associated with future fires, similar to that of the OMFP. General results suggest that another fire is expected within the next 100 years, but not so likely in the next 10 or 20 years (Table 15). As well, if the City were to experience a fire event with the same characteristics of the OMPF, respondents felt that impacts of that fire would be lower than what was experienced in the OMPF, and generally felt that time taken to recover from such a fire would be less than what was experienced after the OMPF.

Table 15: Responses to: "Please use the scale below to rate how likely it is that the City of Kelowna would experience another wildfire event, similar to that of the OMPF?"

In the next:	1*	2	3	4	5	6	7	8	9	10*	Refuse
10 years	–	–	–	1	2	–	1	1	-	–	1
20 years	–	–	–	–	–	–	3	–	1	–	2
100 years	–	–	–	–	–	–	–	–		4	2

* 1=No possibility at all, *10=Absolutely will occur
n=6

Municipal staff generally believed that if the City of Kelowna did experience a similar wildfire event within the next 10 years, the impacts of the fire would be somewhat less severe. Factors that would reduce the severity over this time period included an increased awareness by the public of wildfire risk, increased uptake of private mitigative measures, and increased capacity of the City to respond to wildfire events due to its experience with previous events (e.g., understanding large-scale evacuations, and identifying and managing recovery resources) and other factors surrounding municipal programs aimed at controlling fuel loads and managing development in the WUI.

Staff identified several factors that could increase the risk of sustaining impacts from a future WUI wildfire event, including:

- The impacts of mountain pine beetle kill;
- Climate change factors;
- Increasing development in fire prone areas, and increasing development in the City of Kelowna in general, and;
- Reduced fuel management actions taken by the public over time (as a result of a lowered interest in wildfires as the OMPF falls further into the past).

Staff commented on the potential of infrequent events becoming more common as a result of climate change and beetle kill effects (e.g., a 1 in 100 year fire becoming a 1 in 10 year fire).

Respondents were asked about the potential impacts if a fire exactly the same as the OMPF were to occur again within the next 10 years. They were asked to respond on a scale of 12, where "1" represented "Absolutely no impacts" and "10" represented

"Same severity of impacts as the OMPF." As well, respondents were asked how the time taken to recover would change if the City were to experience another fire exactly the same as the OMPF within the next 10 years. In this case, "1" represented "No time taken at all" and "10" represented "Same amount of time as OMPF." If respondents answered by choosing 12, they would indicate that impacts would be more severe than the OMPF, or more time would be taken to recover than the OMPF. Results are presented in Table 16.

Table 16: Responses to: "If the fire were to occur again in the next 10 years, how would you rate the impacts, in comparison to the OMPF?" and "If the OMPF were to occur again in the next 10 years, how would you rate the amount of time it would take to recover, in comparison to the OMPF?"

	1[1,2]	2	3	4	5	6	7	8	9	10[3,4]	11*	12*	Refuse
a) Impacts	–	–	–	1	–	1	–	2	1	–	–	–	1
b) Amount of time	–	–	–	–	–	1	2	–	–	2	–	–	1

[1] Absolutely no impacts
[2] No time taken at all
[3] Same severity of impacts as the OMPF
[4] Same amount of time as the OMPF
* Impacts or amount of time greater than OMPF
n=6

Respondents suggested that it would be difficult to accurately assess future impacts, due to population changes, changes in municipal staff, climate change, and so on. However, no respondents felt that the impacts would be worse, or that the amount of time taken to recover would be greater than that experienced after the OMPF. All respondents felt that the impacts would be less severe than experienced in the OMPF. Respondents who rated a higher response on Table 16, item "a)" were confident that everything that could have been done was done to mitigate the impacts of the OMPF. Those who gave a higher rating further felt that there would be some improvements, but the majority of the major impacts were mitigated as much as possible during the OMPF of 2003.

Two respondents felt that the time taken to recover from a future fire like the OMPF would be the same as the time taken to recover from the OMPF. Respondents who gave a higher rating felt that, considering the impacts on infrastructure and private residents, two years is a reasonable recovery time. Those who felt that recovery time would be reduced in the future believed that lessons learned from the OMPF would allow for some actions to be taken earlier. For example, the City would be more prepared to handle recovery funds for those affected by the fire, and evacuations could be carried out more efficiently.

4.12.2.1. Impacts of beetle kill

Significant concern by City staff was identified regarding the potential impacts of the Mountain Pine Beetle on the local environment. One such concern was that the infestation might increase the likelihood and severity of future severe fires, as dead and dried forest vegetation provides fuel for wildland fires. Municipal staff indicated that the City's experience with the OMPF and the Rose Valley fire served as examples of how forest areas affected by the mountain pine beetle could affect fire risk, as those areas burned more quickly and readily than areas not affected. Staff expressed concern that as the area affected by the infestation increased, wildfires would become quickly unmanageable and would increase stress on fire-fighting resources.

Staff also indicated that the mountain pine beetle epidemic will likely increase fire risk over the short term, and then decrease it over the long term, as many of the dead trees will have been removed. Staff reported that tree removal is likely to be highest within the City of Kelowna, for safety reasons (e.g., concerns over falling dead trees). Additionally, concerns were raised surrounding the province's and the municipality's ability to abide by the increased requirement for fuel mitigation on Crown lands and lands within the City.

4.12.3. Impact of OMPF experience on management of future disasters

A resilient city is one that can mitigate the impacts of a disastrous event and recover quickly from experienced impacts. Resilient communities should also be better able to mitigate or prevent the impacts of a future disaster of a similar nature and magnitude. Applying lessons learned from a disaster experience is a sign of an adaptable and resilient community.

Respondents were asked to list the top five most significant natural hazards to which the City of Kelowna was exposed. Various natural hazards were cited, including:

- Flooding;
- Wildfire;
- Pine Beetle impacts;
- Critical infrastructure failure (failure of high-pressure water supply pipes);
- Landslides/mass wasting/erosion events;
- Drought;
- Ice storms;
- Weather and wind events, and;
- Earthquake (low risk).

Generally, wildfires and flooding were considered the greatest natural hazards risks.

Respondents believed that their experience with the OMPF has increased their ability to quickly and effectively recover from all types of future hazards. Many of the processes that were established during the OMPF emergency situation, as well as the heightened awareness among city staff of their respective roles during a disaster event would lead to expedited recovery from future natural and non-natural hazard events.

Some respondents further indicated that their experience with the OMPF increased their awareness of how to handle emergency events, and how to work with higher level departments during emergency management and recovery processes. Many also indicated that their experience with the insurance industry would play in their favour in the future.

The experience gained during the OMPF was tested in 2005 during the Rose Valley Wildfire. The Rose Valley fire was also considered a "rank 6" fire; however it did not have as severe an impact on the City of Kelowna as the OMPF. Interviews with City staff indicated that approximately 700 people were evacuated during this incident. Though the Rose Valley fire had a less severe impact on the City of Kelowna, it provided an opportunity to assemble Emergency Operations Centre Staff and employ emergency management procedures. Interviewees indicated that the lessons learned from the OMPF were effectively employed in this incident. For example, an interviewee reported that evacuations were undertaken in a much shorter time period.

There was some concern, however, about the length of time that lessons learned would remain entrenched in the City corporation. One specific concern was that many staff involved in the OMPF were approaching retirement and may not be available in future emergencies. Staff indicated that the majority of those directly involved in the emergency operations centre were senior staff, many of whom would be retiring over the short term. City staff also believed that interest in wildfire mitigation would further wane over time, both within the public at large and within city council.

4.12.4. The role of higher levels of government

As discussed in Section 2.2.1., various levels of government play a role in the management of wildfire hazards. Various government agencies have the potential to play a large role in the management of post-wildfire hazards (FBP, 2005). Discussions with Kelowna municipal staff revealed the perception that the municipal government has played, and should continue to play a substantial role in the management of both wildfire and post-wildfire hazards. For example, the municipal government can and should play a role in the management of fuel loads within their jurisdiction and ensure that development does not expose residents to a high WUI fire risk. During and after the OMPF, higher levels of government played a substantial role in the management of the fire. Interviewees commented that the assistance provided by higher levels of government was fundamental to the successful recovery. For example, interviewees indicated that provincial assistance in the removal of danger trees and hydro-seeding to control erosion and run-off rates was extremely beneficial for the safety of residents, and aided in the recovery process. An interviewee commented:

> …The provincial government, by choosing to hydro-seed all those burnt slopes, I think that was an extremely positive measure… It really mitigated a lot of erosion and probably accelerated the reduction of the flooding risk…

Municipal staff also commented that, at the time of writing, higher levels of government had begun to provide increased cost-sharing assistance for the management of fuel loads on public lands.

However, municipal staff also commented on where they felt the provincial and federal governments could become more involved in the management of wildland fire and post-wildland fire risks.

When asked how the province could become more involved in the management of wildland fire and post-wildland fire risks, interviewees commented that the province should become more involved in:

- Effective management of fuel loads on Crown land, especially in areas adjacent to the City;
- Grant money for emergency management training;
- Assistance with public education, and;
- Working with municipal government to create building codes/standards that would allow for the use of fire-resistance building materials.

Interviewees also indicated that both provincial and federal governments should move toward more pro-active disaster management assistance, rather than strictly focusing on preparedness, response and recovery.

City staff acknowledged the importance of higher levels of government being involved in the management of fuel loads on Crown lands. The B.C. Ministry of Forests was identified as having an important role in mitigating fire risk on Crown lands surrounding municipal jurisdictions. City staff indicated that the provincial government may not be taking adequate steps to manage fuel loads in these areas. Interviewees expressed concern that the impacts of beetle kill in surrounding forests would increase fire risk, and that fuel management activities would have to be enhanced in areas adjacent to municipal jurisdiction. Further, the management of fuel in areas adjacent to the City of Kelowna was a key recommendation made by the Blackwell report (Blackwell & Needoba, 2006).

The use of building codes and standards to manage fire risk in the WUI was also considered an important factor in reducing fire risk in Kelowna. A further key recommendation of Blackwell & Needoba (2006) was to incorporate fire resistant building practices into new development. Roofing materials were considered a particular concern in this regard (Blackwell & Needoba, 2006). Municipal staff felt that the province should work closer with the City of Kelowna, and municipal governments in general, to ensure that fire resistant building practices are enforced in WUI fire risk areas.

Interviewees were also asked to comment on how the federal government could become more involved in the management of wildfire and post-wildfire risks. Generally, the opinion of the interviewees was that the federal government did not have a large role in wildland fire mitigation, as the province and municipalities played the largest role. However, they did feel that the federal government should become more involved in pro-active disaster mitigation strategies at the municipal level. The belief that the federal government should assist in disaster mitigation was exemplified by the proposal for assistance with post-wildfire flood risks (City of Kelowna, 2004a), where assistance was requested based on a risk management and cost-benefit analysis approach.

Interviewees commented on the fact that higher levels of government are typically concerned with preparedness, response and recovery, rather than disaster mitigation. Respondents cited their experience with the mitigation of post-wildfire hazards. For example, interviewees commented that provincial and federal governments provide assistance (financial and otherwise) for controlling wildfire events. However, no support was provided to the City of Kelowna for the identification of fire and post-wildfire risk within their jurisdictions. Interviewees commented that, considering the role that provincial and federal governments play in post-disaster recovery assistance, they should be more concerned with proactive mitigation measures. Indeed, a key argument made in the proposal for assistance with post-wildfire flood mitigation measures was the cost-benefit analysis. The proposal argued that assistance of $1.75 million would save at least five times that amount in provincial and federal emergency response assistance and recovery assistance (City of Kelowna, 2004a).

While staff did indicate a potential need for mitigation funding from the federal government, some staff acknowledged the fact that full funding from the federal government may not be appropriate. For example, staff indicated that through providing full funding for mitigation, the federal government may set a precedent where they would be overwhelmed with requests for mitigation funding. Staff indicated that the federal government should at the least provide some seed money for mitigation projects, and encourage provincial governments to play a larger role in mitigation.

4.12.5. Emergency Response, Evacuations

Interviewees were asked to comment on the various factors that helped to reduce the impacts and consequences of the OMPF. Effective emergency response actions were frequently cited. Further, a key component of the City's autonomy in handling disaster events was, according to municipal staff, exemplified through their management at the Emergency Operations Centres (EOCs), which served as the headquarters for emergency management during the OMPF.

City staff indicated that emergency response activities, including the organization and staff responsible for running the Emergency Operations Centre, were successful. Staff indicated a high level of autonomy within the EOCs during the OMPF. Staff indicated that City staff had control in the EOC. Staff compared this to their knowledge of other communities, where provincial authorities have had to step in and take over emergency management operations.

Incident command during the OMPF applied a Unified Command approach, which is put forward through the British Columbia Emergency Response Management System (BCERMS). Unified command is applied in situations where incidents do not adhere to jurisdictional boundaries, and require the involvement of a range of stakeholders for effective management. The process allows for all levels of government, government

agencies and stakeholders who have a legal, functional or jurisdictional authority to contribute to the planning and management of a particular emergency. Under he unified command system, all stakeholders are involved in:

- Developing objectives and response strategy;
- Ensuring all stakeholders are involved in planning for response strategies;
- Ensuring integrated operations are conducted;
- Efficiently managing all resources, and;
- Managing financial costs (B.C., 2001; 2000).

The purpose of this approach is to ensure that all authorities affected by an incident are involved in emergency management. The process encompasses "consensus decision making, teamwork, sharing/delineating activities, and sharing responsibilities," and differs from the traditional command and control type incident management, where potentially important stakeholders may be left out of the decision making process (B.C., 2001).

The OMPF was a provincial level emergency, and required the attention of many government agencies at various levels of government. Many city departments, and staff from other levels of government were directly involved in the management of the OMPF emergency situation. This circumstance highlighted the importance of a Unified Command, rather than a Command and Control approach. As well, municipal staff indicated that there were many capable staff working within the EOC during the fire event, and the Unified Command structure allowed for appropriate staff and departments to provide guidance on emergency management strategies. The Unified Command structure allowed flexibility in developing strategies to handle the emergency situation and provided the opportunity for a variety of stakeholders to provide guidance on emergency management procedures, thus maximizing available resources.

Staff further discussed the importance of past emergency response exercises undertaken by the City. City staff indicated that an emergency response exercise was completed in 2001, which revealed weaknesses in the City's emergency response capacity. Significant improvements were made, so as to allow an improved response during the OMPF. A staff member commented that, if the OMPF had occurred before the exercise and subsequent reviews to the program, the disaster would have been significantly more severe.

4.12.5.1. Evacuation

The Kelowna fire resulted in an unprecedented evacuation of residents in the City of Kelowna. Municipal staff indicated that concerns existed during the evacuation, about lodging for residents and the ability of the vast number of residents to vacate threatened areas of the City in a very short time period.

Generally, municipal staff indicated that evacuations went well considering the mass scale. However, municipal staff indicated that the evacuation during the OMPF was much larger than anticipated, and much larger than could have been reasonably planned for in the time before the OMPF. Specific concerns were centred around the availability of roads for evacuations. Staff indicated that better evacuation planning would be required for large scale emergencies in the future.

One of the successes identified in the evacuation process was the ability of City staff to increase the accessibility of media reports identifying which areas should be evacuated. Interviewees indicated that initial evacuation notices were of a technical nature (technical metes-and-bounds type descriptions), which may have been difficult for residents to understand. Municipal staff indicated that staff who were involved in map making for the City suggested the use of more accessible evacuation notices, including street names and intersections. This was viewed as a significantly more successful strategy for notifying residents of evacuation areas.

4.13. Barriers to wildfire hazard mitigation in Kelowna

As discussed in Section 2.4.3., municipal governments are often confronted with various barriers and obstacles to the implementation of hazard mitigation options. Barriers to the implementation of mitigation options, as reported by municipal staff, included the following:

- Lack of political support for various mitigation options;
- Jurisdictional issues;
- Lack of support from higher levels of government (financial);
- The financial cost of various mitigation measures;
- The changing nature of wildland-urban interface zones, and fire risk zones;
- Public perceptions of wildfire hazards, and resistance to various mitigation options;
- A limited window of opportunity of public and political interest in wildfire hazards and mitigation options, and;
- Litigation.

Municipal staff generally agreed that building standards that incorporate FireSmart practices, such as fire resistant roofing materials, would be a highly effective wildfire risk reducing action. However, municipal staff indicated that efforts toward requiring fire resistant roofing materials and other risk mitigating building practices have been hampered by the City's lack of jurisdiction over building practices and standards. Further, management of fuel loads in adjacent Crown lands was considered an important component of managing WUI in the City of Kelowna. However, jurisdictional issues were raised regarding the management of fuel on Crown lands adjacent to the City of Kelowna. City staff indicated that as the provincial government has jurisdiction over Crown lands, it was difficult for the City to manage wildland fire risks in these areas.

As discussed above (Section 2.4.2.), provincial and federal governments in Canada offer little support for pre-disaster mitigation options at the municipal level. This circumstance created a significant barrier to the implementation of mitigation options in the City. For example, as discussed in Section 4.10.1.1.1., the City appealed for funding from the federal government for assistance in the implementation of post-wildland fire flood mitigation options. However, no assistance was provided. This situation acted as an obstacle rather than a barrier, as the City did carry out flood mitigation options using its own funds. Interviewees expressed frustration over the lack of assistance provided by higher levels of government, and suggested that Canadian authorities should adopt

mitigation assistance programs similar to the Pre-Disaster Mitigation assistance program and Hazard Mitigation Grant Program adopted by the Federal Emergency Management Agency of the United States (FEMA, 2007).

Cost was cited as an impediment to the adoption of various mitigation measures in the City of Kelowna. As discussed in Section 2.4.3., a good understanding of the costs and benefits of mitigation measures is an important component of the acceptability of various mitigation measures. As natural hazards are, by definition, relatively rare and extreme events, a good understanding of costs and benefits of mitigation measures may not be generated for a considerable time after mitigation measures have been implemented. This has been revealed to be an impediment to the implementation of disaster mitigation measures, especially pre-disaster mitigation measures. This circumstance was observed in Kelowna.

Public perceptions of fuel management approaches were cited as wildfire hazard mitigation impediments, although interviewees indicated that private actions increased significantly during and after the OMPF. Municipal staff indicated the public had unfavorable perceptions of prescribed burning to manage urban forests and to control fuel hazards. Interviewees reported that during the pre-disaster period, there even existed resistance both at the public and political level to fuel management in lands within municipal jurisdiction and lands adjacent to the City. Interviewees indicated that this perception likely existed due to the potential impacts on scenery in the WUI and areas adjacent to the City of Kelowna. Unfavourable perceptions of both prescribed fire and fuel treatments in the WUI have been reported in other communities. Though perceptions may differ based on location and nature of the study sample, prescribed fire may be feared by the public because of safety concerns resulting from escaped fires, impacts on scenic quality in the WUI, and concerns over the health impacts of smoke (Brunson & Shindler, 2004; McGee, 2007; Winter & Fried, 2000). Interviewees indicated that the public resistance to prescribed fire was, at least partly, a result of the above mentioned concerns. Mechanical treatments may be viewed more favourably by those who occupy WUI areas (Brunson & Shindler, 2004). Mechanical treatment became the favoured fuel management option by the City of Kelowna, and in 2007 over $1 million was spent on mechanical fuel treatments in the City. During the OMPF, however, interviewees indicated that removal of fuel on individual properties increased dramatically, and continued after the fire. As well, it was believed that the current Pine Beetle infestation has increased public awareness and support for fuel management. The Blackwell and Needoba (2006) report analyzed perceptions and actions associated with wildland fires in Kelowna and revealed continued support for consideration of fuel management practices in new developments and existing homes in Kelowna.

Uncertainty and the changing nature of natural hazards was reported as a barrier to the implementation of some mitigative actions in Kelowna. For example, since the time of the OMPF, development has increased substantially in Kelowna. As a result, in some circumstances, development exists in areas between wildland areas and communities that were destroyed by the OMPF. Thus, the communities that were affected by the OMPF are no longer located in the WUI zone. This has implications for infrastructure improvements (e.g., increasing capacity of water infrastructure) and altering building standards.

Municipal staff reported that the Works and Utilities department had considered raising water supply standards for WUI areas, through increasing the capacity of water lines to support future fire-fighting efforts. However, as of the date of staff interviews, the City had not implemented increased standards in WUI areas. Municipal staff reported the changing nature of WUI areas, as changes in fuel management practices, environmental changes and development will affect areas that would be considered WUI areas over the long term. Interviewees indicated other issues associated with increasing water supply in these areas. For example, over-sizing water supply pipes in these areas may result in water quality issues.

4.13.1. Litigation and the window of opportunity

Interviewees indicated that a barrier to the implementation of new mitigative programs, and the implementation of "lessons learned" from the OMPF, was the threat of litigation against the City by some insurance companies who provided insurance payouts for damages from the OMPF. Staff estimated that the lawsuit was seeking between $250 to $500 million in damages. Municipal staff indicated that some insurance companies accused the City of failing to take appropriate actions to protect residents and buildings from wildfire damages. Municipal staff indicated that this threat created a culture of conservative communications within the City. Interviewees indicated that there were significant fears among city staff that open discussions and analysis of the events of the OMPF would result in a stronger case being brought upon the City. An interviewee remarked:

> The big fear…is you'll look backwards, you'll analyze what happened, you'll seek to see what [can be] done better, and you'll basically create a shopping list of all those screw-ups. And then… somebody makes a freedom of information request, and somebody gets a copy of it from someone somewhere, and all of a sudden plaintiff council has basically their whole case mapped out for them. I can tell you that was a real concern.

The threat of litigation, and the resulting conservative attitude toward analysis and communication of the events of the OMPF existed for approximately two years after the OMPF. Interviewees indicated that this threat effectively "ate up" the two-year window of opportunity for the implementation of various mitigation strategies following the fire.

Municipal staff indicated that once the suit was withdrawn, much of the public and political interest in mitigating future fire events had been lost. The Blackwell report was released in 2006, and staff indicated that a significant factor in many of the recommendations not being adopted by the report was the threat of litigation. As well, municipal staff indicated that the risk of litigation may have hindered general discussion of wildfire mitigation between the City and other stakeholders, including the province and other municipalities, particularly surrounding the City's experience with the OMPF and discussions of "lessons learned" that could be applied in the City (e.g., as identified in Blackwell & Needoba, 2006) and in other communities. For example, one interviewee remarked:

> There were groups of people that said 'we should get together, and we should improve emergency response in this province, we should improve communication between people and we should improve planning and fire prevention practices…from approvals through to required maintenance and enforcement of such.' …There were groups of people who were championing getting those discussions going, and those people were shut down because of potential litigation. No question about it. It happened.

In reaction to the threat, municipal staff indicated that all reasonable actions had been taken before the occurrence of the OMPF to reduce wildfire risk. In fact, many of the properties that were affected by the OMPF were developed during the 1960s and 1970s, well before WUI wildfire risk considerations were taking into account during planning. The lawsuit was never brought to court, and to date has not remerged as an issue in Kelowna. While it was acknowledged that the City and Kelowna residents could have done more to prevent wildfire damages, interviewees argued that much had been done already. It has been well established in the hazards literature that individuals, as well as communities, are often more aware of natural hazard risks and are more likely to adopt mitigative measure during the post-disaster period (Burton *et al.*, 1993). Thus, a situation where lessons were learned, and mitigative actions that could have prevented damages before the fire occurred were identified, is not a situation unique to the City of Kelowna.

It is important to note that municipal staff indicated that litigation did not hinder the City's efforts for mitigating post-wildfire risks. At the time that the post-fire flood risk was assessed, staff reported that council support for mitigating these risks was actually very high, and there was no mention of public resistance to expenditures on post-wildfire flood abatement infrastructure. Staff indicated that this was likely because the flood risk was identified in the short time following the OMPF, when City council was still highly aware and concerned about hazard risks.

5. Resilience characteristics, recommendations, further work and conclusion

This study sought to explore the experience of the City Kelowna in the management and mitigation of a severe WUI fire event. The study sought to identify strategies that were adopted by the City, and the context in which these strategies were created. In the context of resilience, this study revealed that the City showed adaptability and learning, and was able to recover effectively after the WUI fire event.

The OMPF served as a driver for the implementation and development of new policies and strategies. Similar to other studies (McGee *et al*., 2005), this study found that there was a progression of the adoption of mitigation strategies, before, during and after the fire. As well, local wildland fires previous to the OMPF served as drivers for wildfire management initiatives in Kelowna.

5.1. Characteristics of resilience in Kelowna

The characteristics of a resilient system, as developed by Godschalk (2003) can be applied to the Kelowna case study. Characteristics included redundancy, diversity, efficiency, autonomy, resistance, adaptability, and collaborative (see Section 2.3). Various examples of the eight characteristics of a resilient system are evident in the Kelowna example, which are discussed here.

5.1.1. Redundant

The concept of redundancy is often applied to infrastructure, for example, redundancies in critical infrastructure (water systems, etc.) in the event of failure of a component of the system. However, the concept may also be applied to response and mitigation strategies, as seen in the Kelowna experience.

The concept of redundancy appeared to be well applied to aspects of fire fighting in Kelowna. During the fire, the City extended its own resources to develop a fire break to assist in WUI risk reduction. This approach was combined with extensive fire fighting efforts from various levels of government. In terms of redundancies in long-term mitigation, the City is approaching WUI fire risk with several mitigation options. Land-use planning and hazard mapping are being employed to limit exposure to WUI hazards, combined with fuel-management practices and public education campaigns.

5.1.2. Diverse

An analysis of economic diversity is largely outside of the scope of this study. However, based on previous studies and data from Statistics Canada, some comments can be made.

As discussed by previous authors (Hystad & Keller, 2008), the tourism sector was heavily impacted by the OMPF. Interviews conducted for this paper also revealed that many businesses affected by the fire may have not carried appropriate insurance to handle business impacts from this natural disaster, and many small businesses may have suffered significantly from the impacts of the fire. Though uptake of disaster management plans by these businesses increased over the long-term, many had still not adopted such plans at the time the study was conducted (Hystad & Keller, 2008). Despite impacts on various businesses within the City of Kelowna, the population continues to rise. An early assessment would suggest that the OMPF did not have a significant impact on Kelowna's economy.

5.1.3. Efficient

The handling of various aspects of the OMPF suggested characteristics of efficiency. Examples of efficiency identified in Kelowna include:

- Implementation of fire mitigation strategies before the occurrence of the OMPF, often influenced by earlier local wildland fires;
- The development of a needs assessment and recovery resource management mechanisms to ensure donated recovery fund distribution was efficient and equitable;
- Implementation of a fire guard surrounding the City to reduce WUI fire risk in areas adjacent to the potential path of the OMPF, which was perceived to have saved several communities;
- Implementation of recovery centres to assist private individuals, particularly those affected by the fire, in attaining aid and resources to rebuild homes, and;
- Researching and becoming involved in the management of wildland fire in other communities, and applying lessons learned from other communities.

Though mitigation actions increased after the fire, the actions taken before, during and immediately after the fire were believed by interviewees to have significantly improved the ability of the City and residents in the City to recovery quickly.

5.1.4. Autonomous

A disaster occurs when a community experiences significant disruption of normal processes, in a manner that prevents the community from recovering using its own resources. In contrast, a resilient community is one that can recover from disasters with little or no outside help (Mileti, 1999). According to interviewees, the vast majority of the OMPF disaster situation within the City of Kelowna was handled by City staff. Further, interviewees indicated that the majority of those affected by the fire had proper insurance to cover their damages. Further, the City demonstrated autonomy in the handling of post-fire hazards.

Municipal staff indicated a strong ability to manage the fire emergency within the EOCs, without assistance from higher levels of government. Further, policy reviews and post-fire mitigation and rehabilitation strategies were initiated and funded by the City. Although attempts were made to acquire funds for post-fire mitigation works from higher levels of government, the City took a lead role in assessing risk, developing a mitigation strategy and implementing the strategy, before any funding was secured from other levels of government. Interviewees indicated that the majority of those affected by the OMPF had appropriate insurance, thus, government relief programs (outside assistance) did not play a major role in private recovery efforts. There was some outside assistance provided through private donations, administered by The Society. However, in comparison to all other expenditures, the amount provided was extremely small, and could certainly be considered "little" outside help.

5.1.5. Resistant

As discussed in Section 2.3, the concept of resistance differs from that of resilience, as resistant systems are able to entirely avoid impacts from perturbations. Traditionally, hazard management practices have focused on making physical systems (infrastructure) resistant to hazards, or have applied structures to resist hazard impacts on communities (Godschalk, 2003). For example, buildings can be designed to completely withstand earthquake risks and flood management structures can be built so that communities can resist the impacts of flooding (Geis, 2000). In the context of wildland fires, resistance applies especially in the area of building design. Buildings can be designed to be resistant to wildland fires, through application of fire resistant materials and resistant building practices.

A community that applies effective land use planning to manage hazard risk may also be considered resistant. For example, a community that has effectively prevented or managed development in floodplain areas can be resistant to flood risk. Further, a community that implements land use planning measures to mitigate wildland fire risk can be resistant to wildland fires (Geis, 2000). Resistance can also be promoted through application of setbacks and fuel management practices around buildings in fire-risk areas.

Resistance was present as a component of overall wildland fire mitigation works in the Kelowna case study. For example, WUI hazard areas have been created and fuel management practices have been put in place for new developments. Individual property owners are also being educated on how to manage wildfire risk on their own properties. Further, the fire guard was also an example of a reactionary type of resistance.

Resistance could certainly be improved in Kelowna, as suggested by the Blackwell & Needoba (2006) review, for example through mandating fire-resistant roofing materials in new developments. Through application of land-use planning and fire-resistance building practices, the City of Kelowna is working to increase resistance to future wildland fire events.

5.1.6. Interdependent

The OMPF, and the post-fire impacts affected several departments within the City, and mitigation strategies following the fire had representation from numerous departments.

Management of WUI fire risk in Kelowna included considerations at the individual lot, subdivision, and landscape level. Mitigation efforts at these levels required interdepartmental collaboration and planning. For example, WUI fire management within new subdivisions required the input of the fire department, the planning department (including building inspections and subdivision design) and the department responsible for parks and urban forestry. Interviewees reported that WUI fire hazard area identification was a collaboration between Planning, Fire, Parks and Works and Utilities (Environment Division) departments. Further, staff indicated that individuals from many departments were involved in the handling of the emergency, and at the EOCs.

5.1.7. Adaptable

A resilient community should possess the ability to learn from other communities' experience with hazards and disasters and apply lessons from their own experience. These experiences should be applied so that the community can adapt to hazards, thus reducing the potential impacts from future disasters. Clear evidence exists of adaptation to natural hazard risk in Kelowna. Examples include:

- Applications of lessons learned from the OMPF:
  - Improved hazard identification
  - Consideration of WUI risk in subdivision design (DP areas and wildfire mitigation covenants)
- Employing mechanical fuel treatments, as there is a negative public perception of prescribed burning;
- Development of strategies during the fire hazard:
  - Implementation of a fire guard
  - Adapting government evacuation notices to make them more accessible to the public
  - Staff brought out of various departments to assist, regardless of their official responsibilities

Identifying negative media responses from other communities and developing a media strategy that addressed these concerns

The OMPF served as a driver for the initiation of various strategies to manage the OMPF impacts, as well as implementation of wildfire risk reduction strategies. Table 17 displays actions taken by the City of Kelowna before, during and after the OMPF, and categorizes these actions as mitigation, response, and recovery.

Table 17: Progression of actions

	Mitigation	Response	Recovery
Before the OMPF	• Hazard assessment in WUI areas • Public education initiatives • Vegetation management strategy • Hazard area identification	• Staff involvement and research in other WUI fire situations, allowed for better development of communications plan	
During the OMPF		• Public education program – visiting vulnerable sites and encouraging fuel management on private property • Fire guard • Unprecedented evacuation for City of Kelowna • Communications strategy	
After the OMPF	• Communications regarding non-flood related post-wildfire hazards • Post-wildfire flood abatement initiative • Enhanced vegetation management strategy • Extensive policy review • Enhanced hazard-identification • Development permits and wildfire risk reduction covenants • Continued public education programs • Initiation of selected recommendations from Blackwell & Needoba (2006)		• Development of needs assessment process • Recovery centres • Formation of the Society to equitably and efficiently distribute recovery funds

Adaptation to some barriers was limited. For example, litigation brought against the City by the insurance industry served as a significant barrier, and served to significantly delay the adoption of many mitigation options proposed by Blackwell and Needoba (2006). Despite some barriers, respondents felt that if another event like the OMPF were to occur again in the next 10 years, the impacts would be lower. Interviewees believed that various factors, including new mitigation strategies employed following the OMPF, staff experience with the management of a large fire and evacuation event, and the development of recovery resource management strategies would increase the ability of the City to reduce damages and recover from the event.

5.1.8. Collaborative

The ability of a community to collaborate with external organizations to achieve mutual goals is a further characteristic of a resilient community. Collaboration was evident in the Kelowna case study.

One of the most explicit examples of collaboration in the community following the OMPF was the City's collaboration with non-profits and charitable organizations to develop effective recovery resource management schemes. The City-led initiative ensured that information and resources were shared across all charitable organizations, and the initiative was successful in ensuring equitable and efficient dispersal of donations to those affected by the OMPF according to interviewees in this study.

Interviewees believed that further collaboration with various stakeholders would be beneficial. For example, interviewees believed that the provincial and federal governments would be valuable partners in promoting wildfire and post-wildfire mitigation strategies. As well, interviewees believed that the insurance industry could become a valuable partner, especially through encouraging individual policy holders to adopt risk mitigating actions.

5.2. Recommendations

Based on the exploration of resilience and disaster mitigation in Kelowna, some recommendations are made here. Specific concerns included:

- A low rate of mitigative action by private property owners;
- The role of other stakeholders in promoting hazard mitigation, including the insurance industry, and;
- The role of higher levels of government in mitigation of wildfire and post-wildfire hazard risks.

As well, there was indication from interviewees that vulnerable individuals (those who were socially isolated, those with inadequate insurance and/or living in illegal suites) were a concern during the OMPF.

5.2.1. Adoption of adjustments by private property owners

This study revealed the perception that few private property owners had undertaken mitigative adjustments before the occurrence of the OMPF. Immediately before, during and immediately after the OMPF, however, City staff indicated a significant increase in the adoption of mitigative adjustments, particularly the clearing of debris (fuel hazards) from property. It was also generally perceived that mitigative activities taken by private property owners have likely decreased since the OMPF.

The Blackwell and Needoba (2006) survey revealed differing rates of adoption of adjustments across different neighbourhoods in Kelowna. Over two years has passed since the survey was complete. Research in perceptions and mitigative adjustments undertaken by those vulnerable to hazards suggests that as time passes, individual interest and adoption of mitigative adjustments decreases (Burton *et al*., 1993).

Thus, it is likely that perceptions and behaviours associated with WUI fire risk have changed since the Blackwell and Needoba (2006) survey was conducted. Further, education programs in Kelowna are ongoing, and have likely affected the rate of adoption of adjustments by City of Kelowna private property owners.

It may prove beneficial to conduct a follow up survey of property owners who occupy fire-vulnerable areas within the City of Kelowna. The survey could be used to assess the uptake of mitigative adjustments at the individual level, assess risk perceptions, and assess the impact of City led education programs. Survey results could be used to refine education efforts and could be used as an education tool for the insurance industry.

A longitudinal survey should also be considered, to assess changes in behaviour and perceptions over a long time period. Various factors affect wildfire risk in the Kelowna area, for example, interviewees expressed concern over the Pine Beetle infestation and climate change impacts. Thus, it is likely that individual perceptions may also change over time. For example, as the Pine Beetle infestation affects more forest in the Kelowna area, individuals may have a heightened wildland fire risk perception. A heightened awareness of fire risk may be used to provide support for more aggressive fuel management strategies. Alternatively, if a growing fire risk is not found to affect individual perceptions and mitigative behaviours, education programs should be altered to reflect this information. Further, wildfire mitigation on private lands requires a long-term investment of time in managing fuel loads (Cohen *et al*., 2007). Changing perceptions of risk over time may significantly impact ongoing efforts at mitigating fire risk on private property. A longitudinal survey can be employed to monitor changes in perception and behaviour over the long-term.

Hazard education, in the form of providing hazard risk and methods for risk mitigation to the public, has long been used by authorities to increase awareness and mitigative behaviour in hazardous areas (Mileti, 1999). However, it has often been argued that disseminating information to at risk property owners may not be the most effective means of increasing mitigative behaviour (Cohen *et al*., 2007, Slovic, 1999). Professionals working in the field of risk communication frequently argue that public participation in the risk assessment and hazard risk management process is a necessary, and potentially more effective means of increasing public awareness and mitigative behaviour, as well as increasing democracy in risk assessments (Mileti, 1999; Slovic, 1999). Though public education and awareness are considered essential factors in effective hazards management, Cohen *et al*. (2007: 40) state:

> Strategies for increasing homeowner adoption of risk mitigation measures need to move beyond the communication, education and persuasion approaches that currently dominate most efforts and focus more attention on maintaining trust before, during, and after wildfires, recognising people's need to assign responsibility for negative events.

Increasing public participation in hazard risk management can increase trust in authorities, and therefore increase trust in government decisions related to hazard risk mitigation, and increase acceptance of risk communication messages sent from authorities (Cohen *et al*., 2007; Slovic, 1999).

Case studies from the United States reveal that some communities are taking steps to increase public involvement in WUI fire mitigation. For example, the community of Bastrop, Texas has encouraged private homeowners in the WUI to conduct their own risk assessments (Hudson, 2004). Other communities have involved the public in the development of community-level fire mitigation plans, which include fuel management, subdivision design and structural approaches to fire risk management (Jakes & Sturtevant, 2003). Although comparatively few residents may be involved in public participation initiatives compared to the number of residents who are vulnerable to hazards, evidence suggests that information gathered by a few individuals can spread through a community over time (Nathe *et al*., 1999; Sandink, 2007b).

5.2.2. Identification of Vulnerable Individuals

Interviewees generally felt that individuals affected by the OMPF had appropriate insurance coverage to cover their damages. However, a few instances were identified where homeowners did not have insurance coverage. Particular groups identified by staff included:

- Individuals who live in the forests surrounding Kelowna, possibly of no-fixed-address;
- Individuals occupying illegal suites in WUI, and;
- Uninsured renters.

Interviewees indicated that all reasonable actions were taken to assist vulnerable individuals with their recovery. However, interviewees indicated that these individuals may have suffered greater impacts, as they may have had limited access to resources to help them recover. For example, the occupant of an illegal suite would likely not have had access to insurance. Further, even if the uninsured renter qualified for funds donated to the City, they would likely not have received adequate funds to recover all of their property. Interviewees indicated that individuals who lived in possibly informal residences in the area surrounding the City would likely not have had significant contact with the City or services received from the City in the past, and may have required additional assistance during the recovery process.

Previous research has discussed the differing impacts of disasters on vulnerable individuals. Indicators that have been applied to measure the vulnerability of individuals may include income level (those with lower household incomes are more vulnerable), the elderly, single parent homes, homes with young children and individuals with limited access to resources (knowledge, education, social capital, etc.) (Cutter, *et al*., 2000; Hebb & Mortsch, 2007).

Identification of vulnerable individuals may prove to increase the equitability of disaster assistance in future hazard events. Once identified, vulnerable individuals can be targeted with information tailored to their specific situation, and recovery efforts can be tailored to reflect their specific needs. Data on vulnerability is very limited in Canada, and previous studies that have sought to understand social vulnerability have applied government sources of data, including census data (Hebb & Mortsch, 2007). However, in the case of informal homes (illegal suites, etc.) it may be difficult to identify individuals, as those occupying illegal suites are likely to be left out of census counts. A more aggressive method may have to be applied in the Kelowna case, possibly including a door to door confidential survey.

5.2.3. Collaboration with insurance companies

City staff frequently discussed the belief that individual property owners in Kelowna were likely not taking appropriate actions to mitigate fire risk on their own property. The survey conducted by Blackwell and Needoba (2006) suggested that adoption of mitigative adjustments, including fire resistant roofing, was inconsistent across study areas.

Collaboration with the insurance industry to increase the rate of mitigative action by private property owners was discussed by interviewees in Kelowna. As well, the Blackwell & Needoba (2006) review recommended that governments work with the insurance industry to provide incentives for damage mitigating actions, such as setbacks. The Filmon Review also provided recommendations regarding insurance rates, and promoting fire-vulnerable building codes and land use restrictions. For example, the Review states that "the insurance industry should encourage and reward, through its rate-setting process, dwellings and communities built to acceptable standards" (Filmon, 2004: 29).

The insurance industry in the US has begun to address WUI fire risk at the individual lot level. For example, insurance industry groups have begun to provide educational materials to the insurance industry on the benefits of WUI mitigation measures (IBHS, 2008). Some insurance companies provide financial incentives and requirements to encourage policy holders to adopt fire risk reduction activities (McQueen, 2008). Insurance companies have also provided funds directly to communities for mitigation works. For example, after providing substantial payouts for damaging fires in 1990 and 1996, the SAFECO insurance company provided seed money to the community of Bend, Oregon, which was used to develop a public education program (Jakes & Sturdevant, 2002). Often, these strategies have been adopted by US companies in light of significantly more severe WUI fire damages in the US (see Section 2). Canadian insurers should understand that there exists a significant WUI fire risk in Canada, despite a relatively low occurrence of historical damages. Strategies adopted by the US insurance industry should be reviewed to assess their effectiveness and efficiency, and Canadian companies should be encouraged to apply effective strategies adopted by US companies.

The Blackwell and Needoba (2006) review suggested that it is more difficult to foster structural mitigation measures in existing homes, and therefore the City should concentrate on new development. Encouraging insurer involvement in fire mitigation may serve as a method to increase mitigation adjustments in existing development. For example, financial incentives including lower premiums or disincentives including higher deductibles, may increase owners of existing development to adopt mitigation actions.

Although the majority of homeowners affected by the fire had insurance coverage, municipal staff suggested that there were likely several instances of underinsurance. Staff indicated that in many cases, underinsurance was experienced by those who had renovated homes and had not provided information to insurance companies of such renovations. As discussed in Section 2.5, underinsurance may be a relatively wide-spread problem, and there is evidence that many policyholders do not have a good understanding of their insurance policies, including what is and what is not covered.

It may prove beneficial to conduct a confidential survey of homeowners in defined WUI areas, to assess their knowledge of their insurance policies. The success of the survey may be increased by coordinating efforts with insurance companies that cover individuals in these areas. Insurers could provide input on which homes to contact, on question wording, and in the distribution of surveys. If a high rate of underinsurance is discovered (for example, through questioning whether homeowners have reported home improvements to their insurance provider, or whether home-based business owners have purchased additional insurance coverage), an insurance education program should be conducted for homeowners in the WUI. Increasing uptake of insurance coverage for fire-vulnerable homes will increase the ability of homeowners to recover using their own funds, without the assistance of the City or charitable donations in future severe WUI fire events. Further, involving insurance companies in the exercise will increase the opportunity to educate insurers on wildfire mitigation strategies, and increase interest in working with governments to encourage mitigation actions.

5.2.4. Incentives for Municipal governments

Incentives for the adoption of mitigative mechanisms can be applied not only to individual homeowners, but also to governments. As discussed in Section 2.4.3, many barriers exist for the implementation of disaster mitigation initiatives at the local level. In particular, the difficulty in defining costs and benefits of disaster mitigation and the fact that payoffs for disaster mitigation initiatives may only be experienced in the long-term has been discussed as a barrier to the implementation of mitigation measures at the municipal level. Further, local government political incentives to adopting mitigative adjustments may be limited, as there may be limited public and political interest in disasters in general (Burby, 1998; Kunreuther, 2001).

Researchers have argued that incentives can serve to increase adoption of mitigative adjustments at the community level. For example, Kunreuther (2001) argued for the implementation of public-private partnerships between the insurance industry and governments to create incentives for governments to implement mitigation initiatives. Insurance industry and government partnerships could focus on improving risk estimations, cost-benefit analyses for mitigation options, and incentivizing mitigation actions through lower insurance premiums.

Higher levels of government can also create incentive programs for local governments. Mitigation and recovery aid programs can require that communities prepare mitigation plans to be eligible for assistance. Specific examples of federal government incentives for local governments include requirements under the U.S. *Disaster Mitigation Act* of 2000, and the Community Rating System, a program under the National Flood Insurance Program.

Under the United States' *Disaster Mitigation Act*, communities must prepare multi-hazard mitigation plans to be eligible for various grant and assistance programs provided through the U.S. Federal Emergency Management Agency. Various communities across the U.S. have adopted such plans, and have often listed compliance with the *Disaster Mitigation Act* and resultant eligibility for pre-disaster mitigation assistance as a driving factor in creating and implementing mitigation plans. Further, under the *Disaster*

Mitigation Act, states that have a FEMA approved plan at the time of a disaster can be eligible for increased assistance for the implementation of post-disaster mitigation strategies (20% through Hazard Mitigation Grant Program, rather than 15%). More advanced mitigation plans will result in greater assistance provided for mitigation (FEMA, 2000).

In the U.S., the National Flood Insurance Program (NFIP) provides flood insurance to homeowners in participating communities. The program fosters mitigation of flood damages, for example through providing assistance in identifying flood prone areas in participating communities. Under the NFIP, the Community Rating System (CRS) provides additional incentives for communities to adopt mitigative adjustments that exceed requirements of the NFIP. Communities that participate in the CRS program receive incentives for mitigation and are rated based on the level of mitigation they achieve. Communities are provided a rank from 1 to 10, and communities with a higher rating are provided greater insurance discounts. For example, homeowners in a community with a CRS rating of 9 receive a 5% discount on their flood insurance premiums, and homeowners in a community with a rating of 1 may receive up to a 45% discount on their flood insurance premiums. As well, ratings of communities that participate in the CRS are publicized (FEMA, 2008a,b). This provides an important financial and social incentive to increase mitigative adjustments at the local level.

Though formal incentive programs for communities in Canada are limited, there are some examples from the private sector. The Federation of Canadian Municipality's *Partners for Climate Protection Program* provides an example of an incentive program. Communities who wish to join this program are required to achieve specific targets (milestones), which range from development and implementation, to monitoring and review of results of programs designed to reduce greenhouse gas outputs of communities. Participating communities are listed on a public website site; also listed are the latest milestones which the communities have achieved (FCM, 2008). This provides a forum in which municipalities can compare their progress and show the public the actions they are taking to address climate change. This approach is similar to the public ratings that are provided under the CRS. A similar program aimed at disaster mitigation may prove beneficial in Canada, and may help to increase public and municipal knowledge of mitigation.

The Fire Underwriter's Survey (FUS), administered by a private insurance organization, provides another example of incentives for local governments in Canada (CGI, n.d.). The program allows for insurance industry professionals to rate the capacity of communities to prevent and respond to urban/structural fires, and provides a rating based on their capacity. The survey provides statistical information to insurance companies and also provides feedback to municipal fire departments on improvements that could be made to their fire response services. Survey results are also used to develop the Public Fire Protection Classification (PFPC) of participating communities. Ratings of communities are accessible to insurance companies, and can affect the amount of risk insurance providers are willing to cover in a given community (OFC, 2000).

Incentives may prove to increase the rate of adoption of municipal mitigative adjustments. Incentive program coordination should come from either the provincial or federal governments to ensure consistency at a larger scale. Ideally, standardized risk assessment practices and evaluations would be in place to ensure consistency across the province or country. A database should also be created at the federal level to track and monitor mitigation strategies that have been developed or implemented at the local level to allow for sharing of knowledge and strategies.

5.2.5. The Role of the Provincial government

The province should shift away from assisting with only preparedness, response and recovery, and take a stronger approach to mitigation. Indeed, pre-disaster mitigation has been shown to be far more cost-effective than post-disaster response and recovery. For example, Rose *et al*. (2007) found that mitigation assistance provided through a hazard mitigation funding program in the U.S. yielded a cost-benefit ratio of 1:4 (i.e., each 1 dollar investment in disaster mitigation reduced costs associated damages, response and recovery by 4 dollars). Studies in Australia and the U.K. have revealed 1:3 and 1:5 cost-benefit ratios for mitigation investments (cited in PSC, 2008b). As discussed in the Filmon (2004) review, the cost of fighting the fires in B.C. in 2003 was approximately $700 million. This value could likely have been reduced, had investments in mitigation been in place before the occurrence of the 2003 firestorm.

As discussed above, incentives for municipalities may serve as an important tool to encourage mitigation. However, as provincial authorities have jurisdiction over emergency management, they have at their disposal powerful tools that can be used to require disaster mitigation at the local level. Specific guidelines and requirements for mitigation could be included in emergency management legislation to ensure that municipalities are adopting mitigation as part of their emergency management procedures.

Researchers have argued that knowledge of disaster mitigation is relatively limited at the local level (Henstra & McBean, 2005; Newton, 2003). To increase knowledge of mitigation approaches and benefits, resources and guidelines to assist local authorities in the development and implementation should be developed. These guidelines could be similar to guidelines and resources that currently exist for hazard, risk and vulnerability assessments.

The Filmon Review consistently discusses the importance of implementing building codes and standards to regulate building materials in wildfire risk areas. For example, the report states that:

> The British Columbia government should require municipal and regional governments to implement building codes and land use restrictions that have proven useful elsewhere in limiting the impact of interface fires (Filmon, 2004: 37).

Recommendations surrounding building codes (and standards surrounding land-use for interface fire risk reduction) were also discussed in the province's Garnet Fire Review (Price Waterhouse, 1995). Provincial governments should give full support to communities interested in mitigating fire risk within their jurisdictions and the provincial government should work with municipalities to ensure that institutional barriers to the incorporation of fire resistant building practices in WUI areas are overcome. For example, the province could work with communities to allow for the inclusion of location specific aspects into these codes, and provide local authorities with the opportunity to restrict fire-vulnerable materials in WUI areas (Henstra & McBean, 2005).

A further issue identified in this research is the nature of evacuation notices provided to neighbourhoods during a WUI fire event. As discussed in Section 4.12.5.1, staff from the City of Kelowna altered provincial evacuation notices to make them more accessible to the local population. The province should work with local authorities in providing evacuation notices to ensure that the language used in the notices relates more closely to local circumstances.

5.2.6. The Role of the Federal government

The potential role of the federal government was discussed in the Filmon Review (2004). The Review comments on the potential role of the federal government in interface fire mitigation. Specifically, the review discusses the role of the DFAA in providing some funding during the 2003 fires, and its role in providing funding to other severe natural hazards in Canada. Also mentioned is the fact that there is no funding mechanism to mitigate wildfire hazards before they occur, as the DFAA provides only post-disaster recovery funds. The Review suggests that the federal government should become more involved in the funding of wildfire mitigation (Filmon, 2004).

As discussed in Section 2.4.2.3., the DFAA was amended in 2008 to allow for a payout of an extra 15% of total payouts for mitigation work. However, this mitigation funding is generally aimed at reducing vulnerability to experienced hazards, rather than reducing vulnerability to hazards that were identified through a risk assessment process. Section 3.4.1., where referring to innovative recovery solutions, states that funding for mitigative actions may be considered for a solution that "reduces or prevents *recurrence* of damages" (PSC, 2008a sec. 3.4.1, emphasis added). Referring to public infrastructure funding, the DFAA states that eligible recovery costs include "repairs or replacement to pre-disaster condition of provincial and municipal infrastructure…" (PSC, 2008a, sec. 4.2.1.a). Thus, mitigative funding that would be provided under the 2008 DFAA are for mitigative actions that would mitigate the recurrence of damages, or mitigate damages caused by the recurring event.

Although there was damage caused by the October 2003 heavy rainfall event in the City of Kelowna, much of the mitigative work undertaken was to prevent more serious flood events in other watersheds, including watersheds affected by the October 2003 event. Thus, the mitigative work was based purely on risk assessment, rather than damages caused by the occurrence of an event. For this reason, it would appear that mitigative work would not have been funded even under the current DFAA program.

The federal government should adopt a more proactive strategy for emergency management, through, for example, creating a program that provides partial funds for mitigation projects based on a standardized risk assessment process. There is a precedent for this type of mitigation planning. In 2001, the Australian government undertook a review of its disaster relief and mitigation arrangements. From this review, a new approach to disaster mitigation was adopted, with a shift toward standardized risk assessments and implementation of cost-effective disaster mitigation solutions. Through these initiatives, the Natural Disaster Mitigation Program allows for cost-sharing between federal, state and local agencies for the implementation of disaster mitigation programs. Mitigation measures may be structural or non-structural (Emergency Management Australia, 2004).

5.3. Limits to the Study and Suggestions for Future Work

This study provided an overview of resilience, as discussed by high-level municipal staff, and within municipal documents. The purpose of the study was not to provide a quantitative assessment of the ability of various systems to withstand stresses, but rather a qualitative description and exploration of the innovative strategies employed by the City of Kelowna to counteract a severe disaster event. As such, the approach taken by this paper reflects general (or global) resilience, as discussed by Bruneau (*et al*., 2003). Further, the study sought to understand resilience (mitigation) strategies for only one hazard, with a brief discussion of how the emergency management experience might affect the ability of the community to manage future disasters.

The study, however, has generated new questions regarding the experience of municipal governments with pre- and post-disaster mitigation initiatives, and provides the ground work for continuing study.

Further research should explore the impacts of post-disaster litigation on mitigation choices made by Canadian communities. Although some research has investigated potential liability for inappropriate disaster mitigation at the community level, little work has investigated the impacts of litigation during the post-disaster window of opportunity.

Interviewees discussed political willingness as an obstacle to implementing disaster mitigation strategies. In the municipal context, politicians play a significant role in policy development. Politicians have the final say, for example, in the allocation of public funds to support hazard mitigation projects. Therefore, implementation of mitigation strategies is directly linked to political willingness to accept natural hazards as a threat, and to allocate funds and staff time to implementing mitigation strategies. Political decisions regarding mitigation of hazards and risk are influenced by public perceptions of risk, which are often based on subjective and unscientific assessment of risk (Slovic, 1999). As well, politicians themselves may have only a basic understanding of hazard risk (Newkirk, 2001; Slovic, 1999). Future work should investigate the risk perceptions of municipal councillors, and political (City council) interest in disaster mitigation, and should investigate effective education programs designed to increase political awareness of hazard risk.

The study explored a community which has recently experienced a severe hazard, and has adopted significant strategies to mitigate future risk. It is likely that many other communities are not as prepared for future WUI fire events, and therefore are at a higher risk of experiencing damage in these events. Future work should explore the actions and mitigative strategies employed by a community at risk of WUI fire, that has not experienced a significant hazard for a significant time. This study, and many other studies, revealed that a major WUI fire event was a significant driver in the implementation of mitigation strategies. It follows that communities that have not experienced a local fire hazard for a long period of time may be less likely to have implemented mitigation strategies. Further, strategies developed in progressive communities should be applied in communities which have not developed mitigation strategies.

WUI characteristics change over time, and environmental disturbances (including the Mountain Pine Beetle) serve to change the nature of wildfire risk. Continuing work should be conducted in Kelowna to monitor the perceptions and behaviours of WUI residents as the hazard changes. This work should focus on all WUI areas in Kelowna, including those affected by the OMPF. A follow up survey could be conducted to measure changes in perception and behaviours since that have occurred since the Blackwell & Needoba (2006) survey. A follow up survey should also include questions related to homeowners' insurance coverage, to investigate the rate of under-insurance and uninsurance in WUI areas. Ideally, a longitudinal survey would be implemented to identify changes in perceptions and mitigative behaviours over time. The longitudinal survey can be used, in part, to investigate effectiveness of new subdivision designs, and whether individuals in new subdivisions perceive fire risk and adopt mitigative adjustments, and changes in underinsurance over time.

A more thorough assessment of resilience should investigate resilience of specific services within the City. Analysis would begin with an assessment of the impact of the wildland fire on each and every one of the City's services, and document how impacts were reduced or prevented, and how each service recovered. Following this assessment, strategies should be identified, evaluated and implemented to increase the resilience of each of these services. A study by Chang & Shinozuka (2004) illustrated how this approach can be applied. The study identified earthquake impacts on a municipal water system, and analyzed the effectiveness of various resilience (damage mitigation) strategies.

5.4. Conclusion

The City of Kelowna has employed many actions to manage wildfire risk, including actions that were initiated before, during and after the OMPF. Respondents believed that the City's experience with the OMPF, combined with effective mitigation, response and recovery programs would reduce the impacts of future wildfires in Kelowna. Further, the City applied lessons learned from other communities in some emergency management approaches. The City was also able to adapt to barriers and obstacles presented in various attempts to control WUI fire hazards and post-fire hazards. As well, new recovery and mitigation programs emerged as new challenges were presented during response and recovery from the OMPF.

The City of Kelowna has adopted an interdependent approach to the management of wildland fire risk, across all levels of WUI fire risk (property, subdivision, landscape). However, barriers reduced the ability of the City to implement various mitigation strategies. A significant barrier was a lawsuit brought against the city in the time after the OMPF, which prevented the city from discussing "lessons learned" and implementing recommendations made by Blackwell and Needoba (2006) during the post-disaster window of opportunity.

Considering the increase in disaster events in Canada and worldwide over the past few decades, increasing vulnerability factors and climate change, disaster mitigation should be a priority in government approaches to emergency management. However, disaster mitigation remains a secondary aim of emergency management at the provincial and federal level. Programs designed to transfer funds from higher levels of government to municipalities in disaster situations are aimed at post-disaster recovery, and little assistance is provided for hazards identified through risk assessment processes. Further, jurisdictional issues may reduce the ability of local authorities to take disaster mitigation into their own hands. The case study of Kelowna revealed that municipal governments can be progressive in managing disasters, with a focused and clear understanding of disaster mitigation. Thus, there exists a continued need for governments to work together to promote disaster mitigation and to ensure that local governments can act to mitigate their own risk.

Barriers to disaster mitigation at the local level should be further studied, and strategies to overcome barriers should be identified. The case study explored in this paper found a municipal staff both willing and able to implement strategies to decrease risk to residents, property and infrastructure. Emergency management in Canada should be altered to allow those cities that are willing and able to pursue actions to mitigate disaster risk.

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Appendix A: Summary of November 20, 2007 meeting in Kelowna

November 20, 2007 meeting

A meeting with several high-level City of Kelowna staff, representatives from ICLR and a representative from a private risk management consulting firm attended a meeting organized by ICLR staff on November 20, 2007 in Kelowna. The goal of the meeting was to begin discussion of the methods by which the City of Kelowna is working to reduce its vulnerability to future wildfires and post wildfire hazards, as well as other threats that the community may face. Meeting attendees were provided with a proposal outlining the potential objectives of the project, and provided an annotated agenda to guide discussion at the meeting.

During the meeting, City of Kelowna staff identified several issues related to hazard mitigation in the city, and success of the municipal government during their recovery from the impacts of the OMPF. Specific issues identified at the meeting included:

- a need for a process or framework in which municipal level disaster mitigation work can be supported by higher levels of government, citing specifically Kelowna's experience with post-wildfire flood damage mitigation actions
- The importance of the "window of opportunity" to discuss and implement fire mitigation options and post-wildfire mitigation options. City staff at the meeting indicated that the window of opportunity in which City Council's interest in wildfire mitigation action was highest was two years.
- The impact of insurance sector litigation on discussions surrounding "lessons learned" from the 2003 fire, and the role of litigation as a "barrier" to implementing mitigation actions and projects during the two year window of opportunity. City staff cited specifically recommendations that were made by a private consultant on actions that could be taken to mitigate wildfire risks, as many of the recommended actions were not adopted by the city because the report was presented after the window of opportunity was largely closed
- Political issues associated with hazard risk identification and treatments, including issues surrounding the willingness of the City of Kelowna's council willingness to identify and take action on hazard risk within the city.
- The collaborative atmosphere at the Emergency Operations Centres (EOCs), including empowerment of city staff to control local emergency management operations
- Successes of the comprehensive FireSmart education program undertaken by the City of Kelowna, as well as the successes of other social marketing initiatives undertaken by city of Kelowna departments to address homeowners resource use issues
- Other hazards, both natural and non-natural, that pose a threat to the city of Kelowna. Specifically, some staff identified flood hazards as a greater threat to the city of Kelowna than wildfire recurrence

Appendix B: Participants

Participant	Workshop	Survey
Rene Blanleil, Fire Chief, Fire Department, City of Kelowna	●	●
Don Degen, Water and Drainage Manager, Department of Works and Utilities, City of Kelowna	●	●
Lance Kayfish, Risk Manager, Department of Financial Services, City of Kelowna	●	●
Ron Mattiussi, City Manager, former Director of Planning and Development Services, City of Kelowna	●	●
John Vos, Director of Works and Utilities, City of Kelowna	●	●
Mark Watt, Environment and Solid Waste Manager, Department of Works and Utilities, City of Kelowna	●	
Ian Wilson, Urban Forestry Supervisor, Department of Recreation, Parks and Cultural Services, City of Kelowna	●	●

Appendix C: Interview Survey

1. Perceptions of Overall Impacts

a) In your opinion, how would you rate the severity of the overall impacts of the OMPF on the City of Kelowna?

Extremely minor									Extermely severe
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
1	2	3	4	5	6	7	8	9	10

b) Using the scale below, please rate how satisfied you are that everything possible was done to reduce the impacts of the OMPF on the City of Kelowna:

Very dissatisfied	Somewhat dissatisfied	Neither satisfied nor dissatisfied	Somewhat satisfied	Very satisfied
☐	☐	☐	☐	☐

c) Overall, how many months/years did it take for the City of Kelowna to fully recover from the impacts of the OMPF?

_____ months, _____ years.

d) Using the scale below, please rate how satisfied you are that everything possible was done to reduce the amount of time required for the City of Kelowna to recover:

Very dissatisfied	Somewhat dissatisfied	Neither satisfied nor dissatisfied	Somewhat satisfied	Very satisfied
☐	☐	☐	☐	☐

e) Which components, departments or sectors of the City suffered the most significant impacts?

f) Which components, departments or sectors of the City required the most time to recover?

2. Perceptions of impacts on department

a) In your opinion, how would you rate the severity of the overall impacts of the OMPF on your department?

Extremely minor									Extermely severe
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
1	2	3	4	5	6	7	8	9	10

b) In which ways did the OMPF affect your department?

c) How many weeks/months/years did it take for your department to fully recover from the impacts of the OMPF?

_____ weeks, _____ months, _____ years.

d) Did the OMPF result in any permanent impacts on your department?

☐ Yes ☐_No

3. Perceptions of impacts on individuals

a) Following the OMPF, how many months/years did it take for those who lost their homes to rebuild, and move into their new homes?

_____ months, _____ years.

b) Are there any residents who have not yet fully recovered from the impacts of the OMPF?

☐ Yes ☐ No

c) What were some of the most effective tools, implemented by governments, private agencies, or by the public themselves, that **reduced the overall impacts** on individuals directly affected by the OMPF (e.g. through evacuation or destruction of homes)?

d) What were some of the most effective tools, implemented by governments, private agencies, or by the public themselves, that **reduced the amount of time** it took for affected individuals to fully recover (e.g. for evacuees to return to their homes, or for residents to rebuild their homes)?

e) Please rate your agreement with each of the following statements my placing a check in the appropriate box:

i) **Before the OMPF**, the residents of Kelowna who were at risk of sustaining damages from wildfires had taken all necessary actions to reduce the risk of wildfire damage.

☐	☐	☐	☐	☐
Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly disagree

ii) **As of today**, the residents of Kelowna who are at risk of sustaining damages from wildfires have taken all necessary actions to reduce the risk of sustaining damages from future wildfires.

☐	☐	☐	☐	☐
Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly disagree

4. Community level mitigative actions

a) What were some of the most effective tools in use in Kelowna for reducing the risk of wildland fire damages, **before the occurrence of the OMPF**?

i) Which of these tools were implemented by your department?
   a) Who were some of the key stakeholders involved in developing these tools?

ii) Were there any key individuals who drove the implementation of these tools?

iii) What were some other key factors that lead to the development and implementation of these tools?

iv) Have these programs/tools changed since the occurrence of the OMPF?

b) What are some of the most effective tools **currently in use** in Kelowna for reducing the risk of wildland fire damages?
   i) Which of these tools were implemented by your department?
      a) Who were some of the key stakeholders involved in developing these tools?
   ii) Were there any key individuals who drove the implementation of these tools?
   iii) What were some other key factors that lead to the development and implementation of these tools?
   iv) Would these programs have been implemented had the OMPF never occurred?

c) What were/are some of the most effective tools used in Kelowna to reduce the risk of damages from **post-wildfire hazards**, caused by the OMPF (e.g., increased risk of flooding)?
   i) Which of these tools were implemented by your department?
      a) Who were some of the key stakeholders involved in developing these tools?
   ii) Were there any key individuals who drove the implementation of these tools?
   iii) What were some other key factors that lead to the development and implementation of these tools?

d) What role did **government relief programs** and **insurance** play in reducing the impacts, and reducing the amount of time it took for Kelowna to recover from the OMPF?
   i) How could these tools be improved?

e) Were any other communities looked to as models or examples of how to act, or how not to act in the event of a serious wildfire event?

5. Unimplemented Tools and Barriers to Implementation

a) What are some effective wildfire risk mitigation tools that you think should or could be implemented in Kelowna, but have not been implemented?

b) What were/are the major barriers that have prevented important programs from being implemented?

6. Lessons Learned

a) What were some of the major "lessons learned" from the OMPF?

b) Which processes, actions, etc. would you not change in future wildland fire events (e.g., processes that worked very well, and could not be improved)?

7. Perceptions of risk

a) Please use the scale below to rate how likely it is that the City of Kelowna would experience another wildfire event, similar to that of the OMPF:

	No possibility at all									Will occur
Within the next 10 years	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	☐ 8	☐ 9	☐ 10
Within the next 20 years	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	☐ 8	☐ 9	☐ 10
Within the next 100 years	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	☐ 8	☐ 9	☐ 10

7. Perceptions of risk (continued)

b) On the scale below, the number 10 represents the overall impacts that the 2003 OMPF had on the City of Kelowna. If the OMPF were to occur again in the next 10 years, how would you rate the impacts, in comparison to the 2003 OMPF? (A rating below 10 would indicate that you believe the impacts would be less severe, and a rating above 10 would indicate that you believe the impacts would be more severe.) Please explain your response.

Absolutely no impacts									Same severity of impacts as OMPF			(higher than 12)
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	☐ 8	☐ 9	☐ 10	☐ 11	☐ 12	☐

c) On the scale below, the number 10 represents the overall amount of time that was required to recover from the impacts of the 2003 OMPF. If the OMPF were to occur again in the next 10 years, how would you rate amount of time it would take to recover, in comparison to the 2003 OMPF? (A rating below 10 would indicate that you believe that less time would be required, and a rating above 10 would indicate that you believe more time would be required.) Please explain you response.

No time required									Same amount of time as OMPF			(higher than 12)
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	☐ 8	☐ 9	☐ 10	☐ 11	☐ 12	☐

8. Attributions of responsibility

a) Please rate the **current responsibility** of each of the following entities for the mitigation of **wildfire hazards** using the provided scales:

	Not responsible at all					Entirely responsible
Municipal government	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
Regional government	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
Provincial government	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
Federal government	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
Private homeowners	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
Private business owners	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6

Others _____

_____

_____

_____

8. Attributions of responsibility (continued)

b) Please rate the **current responsibility** of each of the following entities for the mitigation of **post-wildfire hazards**, using the provided scales:

	Not responsible at all					Entirely responsible
Municipal government	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
Regional government	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
Provincial government	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
Federal government	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
Private homeowners	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
Private business owners	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6

Others _____

_____

_____

_____

c) In what way do you think higher levels of government could become more involved in the mitigation of post-wildfire risks?

9. Hazards to which Kelowna is exposed

a) In your opinion, what are the top 5 most significant natural hazards to which the City of Kelowna is exposed (e.g., natural hazards that have a high probability of occurrence and a high potential for severe impacts)?

1. _____

2. _____

3. _____

4. _____

5. _____

9. Hazards to which Kelowna is exposed (continued)

b) In your opinion, what are the top 5 most significant non-natural hazards (e.g. critical infrastructure failures, terrorism, chemical spills, human-caused fire, etc.) to which the City of Kelowna is exposed (e.g., non-natural hazards that have a high probability of occurrence and a high potential for severe impacts)?

a. _____

b. _____

c. _____

d. _____

e. _____

10. Impact of OMPF Experience on Other Hazards

a) Has the City of Kelowna's experience with the OMPF increased its ability to reduce the impacts of and quickly recover from other types of future **natural hazards** (for example, the hazards that were identified above)?

b) Has the City of Kelowna's experience with the OMPF increased its ability to reduce the impacts of and quickly recover from future **non-natural hazards** (for example, hazards that were identified above)?.

Appendix D: Blackwell & Needoba (2006) Recommendations

Landscape Level Risk Assessment

- *Consideration of working with the B.C. Building Policy Branch to allow for better incorporation of WUI fire risk reducing building practices (Priority: High, Responsibility: Inspection Services)
- *Lobby the provincial government, potentially with other municipalities within the Okanagan region, to encourage fuel mitigation on Crown land adjacent to WUI communities within the city of Kelowna (Priority: High, Responsibility: Fire Department)
- The City should investigate the establishment of agreements with the Province that would allow developers to treat Crown land directly adjacent to new developments as a required part of the development process. Provinces would then pay the mitigation cost to the developer upon satisfactory completion of the work.

Considerations at the subdivision level

- *Incorporation/phase in of fire retardant roofing materials in new and existing WUI subdivisions (Priority: High, Responsibility: Planning and Development Services)
- *Work toward improving access in isolated areas of the City for evacuations and fire control (Priority: Medium, Responsibility: Planning and Development Services)
- *Integrate access points into new subdivisions during subdivision design, to facilitate evacuation and access for emergency response equipment (Priority: High, Responsibility: Works and Utilities)
- *Place roads between subdivisions and forested lands, in instances where new subdivisions will be adjacent to forested lands to improve access and to act as fire breaks (Priority: Medium, Responsibility: Planning and Development Services)
- *Consider proximity of hydrants with respect to access points for forested parks, during design of new subdivisions (Priority: High, Responsibility: Planning and Development Services)
- *Consideration of the adoption of a standardized Registered Professional Forester reports, required as part of the Development Permit waiver process, to ensure consistency of hazard mitigation activities within all subdivisions in the Development Permit Areas (Priority: High, Responsibility: Planning and Development Services)
- The City should investigate the potential of partnering with residents to promote treatment of public lands adjacent to private property. Private land owners could be encouraged to not only clean their own yards of debris and brush but also to be responsible for the removal of debris and brush from public lands immediately adjacent to them to a depth of 20 metres. Removal of material would be coordinated with the spring yard waste pickup program
- The City should work with the local development community to construct a City owned FireSmart show home that can be used as a tool to educate and communicate the principles of FireSmart to the public. The demonstration home would be built to FireSmart standards using recommended materials for interface communities. Vegetation adjacent to the home would be managed to guidelines outlined in the FireSmart program and would be both fire resistant and drought tolerant in nature

- City should proactively enforce wildfire covenants requiring owners to maintain their properties hazard free on all properties in Wildland Fire Hazard Development Permit areas. Enforcement will serve to minimize fuel risks on problematic private properties and provide improved protection to adjacent lands
- City staff should investigate the creation of a process whereby new development on a given parcel that directly abuts an untreated private parcel triggers a requirement that the developer contact the adjacent landowner seeking permission to treat the bordering area to a distance of no less than 100 m creating an immediate defence zone for the new development. This would reduce wildfire behaviour potential in the short term; however, a solution would still be needed to address maintenance of these treated areas if they are not developed within the next 10 years

Individual lot considerations

- The city should develop a landscaping standard for vegetation within Wildland Fire hazard Development Permit areas. The vegetation contained in the proposed standard should attempt to meet both the goals of fire resistance and drought tolerance to ensure water conservation. This standard should be applied to all new properties within the proposed Wildfire DP areas and be implemented on existing properties when building permits are requested for renovations/retrofits
- Many homes are built immediately adjacent to the forest edge. It is recommended that the City alter the Zoning Bylaw to require that developers leave building set backs on private land so that there is a minimum distance of 10 m between buildings and the forest interface. This standard should be applied to housing bordering both City owned and forested private land

Management of parks and green spaces

- *Inventory sensitive ecosystems to ensure they are not adversely affected by fuel treatments and other park developments (Priority: High, Responsibility: Planning and Development Services)
- *Adoption of a standard for fuel management in parks and green spaces (Priority: High, Responsibility: Parks Department)
- *Management of fuel in heavily traveled trail networks and corridors to limit fire spread and improve fire suppression abilities (Priority: Medium, Responsibility: Parks Department)
- *During subdivision development, consolations should be held with the parks department to allow for reviews of wildfire hazard mitigation plans developed for subdivisions before areas are delivered to the City, to allow for a parks department site inspection of mitigation work undertaken in areas to be delivered to the city, and for review of mitigation plans and work on private portions of subdivisions (Priority: High, Responsibility: Parks Department)
- *Require developers to mitigate fire hazard on forested lands, before they become the property of the City (Priority: High, Responsibility: Planning and Development Services)

- Prescribed fire and the use of a curtain burner should be allowed in order to improve the cost effectiveness of fuel treatment and expand the area of treatment. Any use of fire should strictly follow smoke management guidelines to limit the impacts of smoke
- Where fire control access could be improved in City parks, and the resulting ecological impacts are considered acceptable, consideration should be given to widening specific trails to 3.2. metres (the width required for small emergency vehicle access). This should involve the removal of all obstacles such as trees and stumps but the trails should remain unpaved. Access points should be provided where they are feasible and effective.

Other Considerations

- *Enhancement of public education programs through integration of a unit of wildfire safety into local primary school curriculum, and create a FireSmart "sticker" program to identify properties that meet FireSmart guidelines (Priority: Medium, Responsibility: Fire Department)
- The City should create an interactive website that outlines community fire risks and proactive steps individual homeowners can take to make their homes safer within the community. Other information, such as fire danger, FireSmart principles and reporting on recent treatment initiatives in the community could be maintained on the local site so that fire management issues specific to Kelowna could be easily communicated to the local population
- The city should assess funding options, such as a congregation plant, composting program or a minimal increase in property taxes, which could be used to encourage and aid property owners with fuel mitigation and to facilitate treatments on public lands.

*Actions slated for adoption in 2007

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The Institute for Catastrophic Loss Reduction, established in 1998, is a world-class centre for multi-disciplinary disaster prevention research and communications. ICLR is an independent, not-for-profit research institute founded by the insurance industry and affiliated with the University of Western Ontario. ICLR staff and research associates are recognized internationally for their expertise in wind and seismic engineering, atmospheric science, risk perception, hydrology, economics, geography, health sciences, and public policy, among other disciplines.

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